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GUGLIELMO MARCONI
The father of radio

RADIO BROADCAST

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RADIO CURRENTS

AN EDITORIAL INTERPRETATION

TWO years ago the only interpretation of the word "receiver" would have been a man appointed by the courts to take over a bankrupt firm. But such is not the case to-day—"receiver" also refers to the hundreds of thousands of people who are nightly "listening in" to the various radiophone broadcasting stations distributed over the country. What attitude are they going to take in the future in regard to the amount and kind of broadcasting these stations give? In other words, are the hundreds of thousands of families which now get their evening entertainment at home instead of going out to the theatre or movie, going merely to receive what is "handed out" to them gratuitously by the manufacturing companies, or are they going to exert their influence in such a way that the entertainment offered them is determined by themselves. The question is a broad one and of rapidly growing importance; there are many peculiar angles to the problem which make it different from any apparently similar one, in fact the problem is probably unique. A few of its phases are pointed out in this discussion.

In this latest application of scientific achievement there are two essential parts, a transmitting station from which the radio broadcasting is done and the station at which it is received. If you have a receiving station, you come under our classification of *receiver*, and it is in your attitude toward the transmitting station that we are interested. Did it ever occur to you how very helpless you are in this new activity? You turn on your switches and wait—if you hear nothing you conclude the transmitting station has not started so you wait and wonder what is going to be sent out when it does start. It may be a selection from "Aida", wonderfully executed, or it may be nothing but a scratchy, cracked, phonograph record. You have nothing to say about it, you pay nothing for it, and, still more to the point, you have no rights in the matter at all. You are not alone in this game of watching and waiting—there are hundreds of thousands of others, and soon there will be millions of people doing the same thing.

The rate of increase in the number of people who spend at least a part of their evening in listening in is almost incomprehensible. To those who have recently tried to purchase receiving equipment, some idea of this increase has undoubtedly occurred, as they stood perhaps in the fourth or fifth row at the radio counter waiting their turn only to be told when they finally reached the counter that they might place an order and it would be filled when possible. Also to the man who has the reputation among his friends of knowing something about radio, this rapid rise of interest in radio has been forcibly brought home. He is scarcely engaged in conversation before the familiar phrase sounds—"I suppose everybody else has been bothering you, but my boy

wants a radio set and the family— What size wire shall I use, and should the joints be soldered—?" In the ferry boat and in the subway trains we hear of wavelengths, frequencies, capacities, tubes, amplifiers, etc. in connection with strange combinations of letters—KYY, KDKA, and what not. The teacher of radio, judging by the number of applicants for membership in his classes, finds that his subject is really just as important as he always thought it was and perhaps even more so. He finally sees the whole world "coming to its senses" just as the phonograph salesman sees the whole world losing its senses in the same process.

But to probably no other group of men has this tremendous interest in radio come with more force than to the manufacturers of radio apparatus. Anything they could make, good or poor, could be sold before the varnish was scarcely dry. And speed up the shop processes as much as they could the pace was too fast and they fell behind in filling orders. And when the American manufacturer, in a time of general depression such as has existed for the last two years, owns up to the fact that he cannot keep his output to the demand, it is safe to conclude that the rate of increase in the demand for his apparatus has indeed been phenomenal.

The movement is probably not even yet at its height, it is still growing in some kind of geometrical progression. There are to-day probably five hundred thousand receiving stations in the United States, although, of course, any such statement must be based largely on conjecture. It seems quite likely that before the movement has reached its height, before the market for receiving apparatus becomes approximately saturated, there will be at least five million receiving sets in this country. This means that before many years there will be from ten to twenty million people who can be reached by radiophone communication. These millions of people will be dependent upon a few broadcasting stations for their amusement and "up to the minute" news; over the policies and conduct of these transmitting stations this vast army of listeners will have no influence at all, unless some movement for organization is started which is not yet evident.

It might well be thought that there is nothing strange in the situation, that in many other activities in which the public has invested a deal of money, and upon which it is very dependent, a similar condition of helplessness exists for those who have invested. But closer examination of the question shows this to be not so. If our surmise as to the number of radio receiving stations in the near future is correct, then the situation, in so far as amount of money invested by the public, the number of persons interested, etc., may be somewhat similar to that of the telephone or phonograph.

The telephone subscriber invests perhaps fifty dollars a year for which he gets certain privileges; to get the return on his fifty dollars the company must keep their lines in condition —if they don't the subscriber gets little for his money. But the company does keep up its lines because they expect the subscriber to invest another fifty dollars the next year and so on, so it is to their interest to maintain their service from the standpoint of sales. Also if the lines are not kept in such condition as to render the subscriber satisfactory service, a public utility commission will order them to be so kept. With the lines kept in useable condition the subscriber gets his money's worth; he can telephone when and where he likes. For this privilege the subscriber pays.

The man who invests in a radio outfit however has no such choice; he can simply listen. Of course it is conceivable that he might also have a transmitting outfit and he would then have the same possibility the telephone subscriber has. Such a possibility is extremely remote; instead of increasing the number of transmitting stations in the future in proportion to the number of receiving stations, it seems likely that there will be but little increase, and this increase will include none but public broadcasting stations. The general public therefore must always play the rôle of listener merely, when it comes to radio.

The man who purchases a phonograph is practically dependent upon the manufacturer to get any good out of his investment. For example, if some new type of phonograph should be produced with records cut in such a special way that no one else could furnish them, then the owner of this phonograph would be entirely dependent upon the manufacturer to make his investment good. In this case the manufacturer will naturally furnish as many good records as possible because there is money in the game for him. But if the records had to be supplied to the owner of the phonograph at cost, so that there was no profit in it for the manufacturer, he would probably cut new records just long enough to sell sufficient phono-

graphs to saturate the market. After that, there being no more money in the game for him, he would probably invest in some other enterprise. The excellent service the phonograph companies furnish the public is maintained only because there is a profit in it for them. Because of this profit the list of records available continually grows both in comprehensiveness and quality, so the owner of the phonograph gets continual enjoyment by getting the new records as they appear. It will also be noticed that in the case of the phonograph each family or person may select and play just those records they most enjoy.

Now in the case of the radio receiver it is evident that there is at present practically no choice as to the kind of entertainment furnished—every one must take the same, whenever he can get it. In some parts of the country the entertainment offered is of high quality, but every one must realize that artists will not continue to give their services for nothing; after the novelty has worn off it will cost money to get talent at the broadcasting station and the question arises—who is going to pay for it?

For some time yet to come it will pay the manufacturing companies to maintain the quality of the entertainment sent out from their broadcasting stations at a high level so that those having receiving outfits will be enthusiastic about it and so get others to buy. The cost of maintaining the transmitting station will, of course, be one of the items fixing the selling price of the receiving apparatus. But after a while the rate of increase in the sales will fall off as the market gets more saturated and the demand will settle down to a comparatively small steady value. If the sale of receiving apparatus is to cover the cost of operating the transmitting stations, it seems likely that the price of receiving sets will have to rise continually—and they are high enough now! The peculiarity in the radio situation, as compared to the phonograph situation, is that the manufacturer's interest in the customer is necessarily much reduced after the sale of the apparatus; there is practically no more profit to be gained from the man owning a set, as the cost of renewal parts of the radio receiver is small, unless the man as he becomes more enthusiastic can be made to buy a better set.

It would seem then that the solution of the problem will finally involve some different scheme of financing than that used at present. There are various schemes possible, of which the most attractive one, in so far as the general public is concerned, is the endowment of a station by a public spirited citizen. This may sound at present like a peculiar institution to endow, but it seems sure to come. We have gymnasiums, athletic fields, libraries, museums, etc., endowed and for what purpose? Evidently for the amusement and education of the public. But it may well be that in the early future the cheapest and most efficient way of dispensing amusement and education may be by radiophone.

A powerful station in the vicinity of a large city like New York would reach at present perhaps one or two hundred thousand persons. The writer gave a broadcast lecture a short time ago, and the optimistic-manager of the station assured him there were probably two hundred and fifty thousand people listening. Such an audience would be impossible by any other scheme. A lecturer can, at such a station, reach more people in one evening than he could on the lecture platform in a year of speech making.

The first cost and maintenance cost of a powerful station are not prohibitive when compared to that of other institutions designed to do as comprehensive a piece of work. Thus a powerful station could be put up and operated at a cost less than that required for a reasonable sized library, and there is no doubt that a properly conducted radio broadcasting station can do at least as great an educational work as does the average library. This is not said to disparage the endowment of libraries but to point out another way for the wealthy citizen to invest part of his excess wealth for the public good. To one with vision of the probable growth of radio communication, the endowment of such a station should appeal strongly and there is much likelihood than many such stations will be operating in the next twenty-five years.

Another possible scheme for the maintenance of suitable broadcasting stations is by contributions to a common fund, which would be controlled by an elected board; this would be one of the more difficult ways of carrying on the work, for the reason that any one can listen in on a broadcasting station whether he contributes to its support or not. The financing of such activities, in which contributions are made by those who choose, the benefits of which all may equally enjoy, is rather difficult,

and the board of managers would have an unenviable task. In certain communities it would undoubtedly work just as do the societies for upholding property restrictions in various localities; voluntary subscriptions support the legal talent required to maintain the restrictions, but all who live in the community obtain equal benefits whether they contribute or not.

A third way, and probably the most reasonable way, to operate the transmitting station is by municipal financing. A weird scheme this will undoubtedly appear to many, but upon analysis it will be found not so strange, even to those who have no socialistic tendencies. In New York City, for example, large sums of money are spent annually in maintaining free public lectures, given on various topics of interest; the attendance at one of these lectures may average two or three hundred people. The same lecture delivered from a broadcasting station would be heard by several thousand people. Because of the diverse interests of such a large city as New York it would probably be necessary to operate two or three stations from each of which different forms of amusement or educational lectures would be sent out. The cost of such a project would probably be less than that for the scheme at present used and the number of people who would benefit might be immeasurably greater.

Of course it has been assumed in the foregoing discussion that the speech or music as delivered by the radio receiving set is practically as good as that delivered by the performers or lecturer at the transmitting station. At present this is certainly not so; the small crystal sets, requiring head telephone sets, do give fairly good reproduction provided that the transmitting station is functioning properly, but the wearing of a head set is not a pleasant way of spending an evening. When vacuum tube receiving sets are used, attached to amplifiers and loud speaking horns, there is generally a good deal of distortion. In such a case the listener would evidently prefer to listen to the lecturer directly. The end is not yet, however —loud speaking receivers are at present very crude devices compared with what they may be; they nearly all give fair reproduction of music, but for speech they are somewhat lacking in performance. This is not an insuperable difficulty and a good loud speaker is almost sure soon to appear. Then the speech will be clearer than would be the case if the lecturer were in a hall and the listener were one of the audience; the lecture may be enjoyed by the whole family seated in easy chairs and if the lecturer prove to be tiresome the set will be re-tuned to some other station offering a more attractive programme.

As has been stated several times in the foregoing discussion, the day of radio reception is just beginning; as it grows in scope and importance it will be necessary for some of the receivers to see the issue clearly and lead in the movement for better and more diversified broadcasting stations. Troubles from interference between different transmitting stations, government control of licensing, etc., will be necessarily an important part of the scheme of development, but to one understanding the fundamentals of the art these do not offer appreciable difficulties to carrying out the programme suggested above.

J. H. M.

EDITOR'S NOTE

It is of the utmost importance to the radio public who are receiving broadcasting that this business develop to its maximum service and effectiveness. The Editors of RADIO BROADCAST *would be glad to hear the opinion of its readers on such questions as:*

What voice should the receiving public have in selecting broadcasting programmes?

Should the public get broadcasting free or should it pay for it, and if so how?

If the public should get it free who should pay for it and how are they to be reimbursed?

INTERFERENCE IN RADIO SIGNALLING

By JOHN V. L. HOGAN

Fellow and Past President, Institute of Radio Engineers. Member American Institute of Electrical Engineers

In the following article Mr. Hogan's discussion is based entirely upon the modern and scientifically useful relation of wave frequencies. The more familiar concept of wave length as a basis of tuning is equivalent to the idea of wave frequency, and radio frequencies can be converted into meters wave length simply by dividing into the factor 300,000,000. Thus a frequency of 500,000 cycles corresponds to a wave length of 600 meters or 300,000,000 divided by 500,000. Similarly, the present broadcasting wave length of 360 meters corresponds to a frequency of 300,000,000 divided by 360 or about 833,000 cycles per second.

IN RADIO communication systems the word "interference" has been used for many years to describe what happens when a receiving operator hears, in his instrument, signals from stations other than that from which he desires to take messages. The signals from his own communicating station, that is, the transmitter to which he desires to listen, may be comparatively loud and clear. In this instance, the sounds heard from the other stations will be relatively feeble and only slight "interference" will be experienced; in other words, the receiver will be troubled only slightly, if at all, by the interfering or disturbing sounds and with little difficulty will be able to concentrate upon and decipher the signals he desires to receive. On the other hand, he may be listening to relatively faint sounds from a distant transmitter, anxious to record every word that is sent out, and without warning a powerful near by sending station may commence operations. In this instance the strong interfering waves produced at so short a distance from the receiving station may blot out completely the signals from the far-away sending plant, thus producing insuperably strong "interference." Between these two extremes all shades and colors of interference may be experienced, from a misty background of buzzing against which the desired signals stand forth strongly and distinctly, to interference between several stations of so nearly equal intensity that (when all are sending) it is impossible to distinguish a word from any one of them. Such a gamut of interference has existed from the earliest days of commercial radio signalling, and its minimization or elimination has long been one of the outstanding problems of radio. The natural consequence of such a problem is that the most skilled scientists in the field have applied themselves to finding the solution; the consequence of such intent study is that vast and indeed gratifying progress has been made in overcoming the difficulties created by interference.

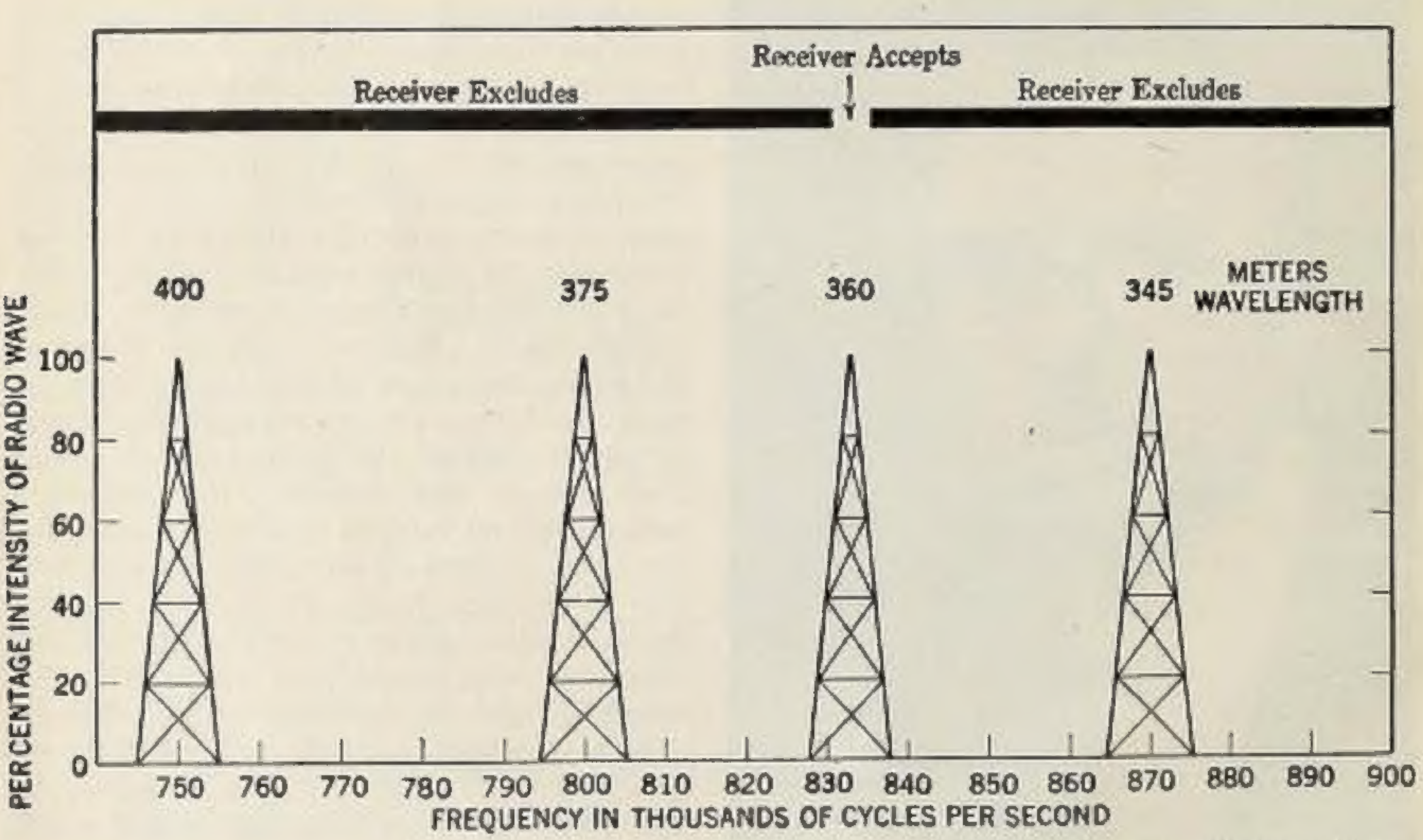
JOHN V. L. HOGAN
radio engineer, an early worker with Dr. Lee de Forest. In 1920, President of the Institute of Radio Engineers

The keynote of the most successful normal systems which have been developed to reduce

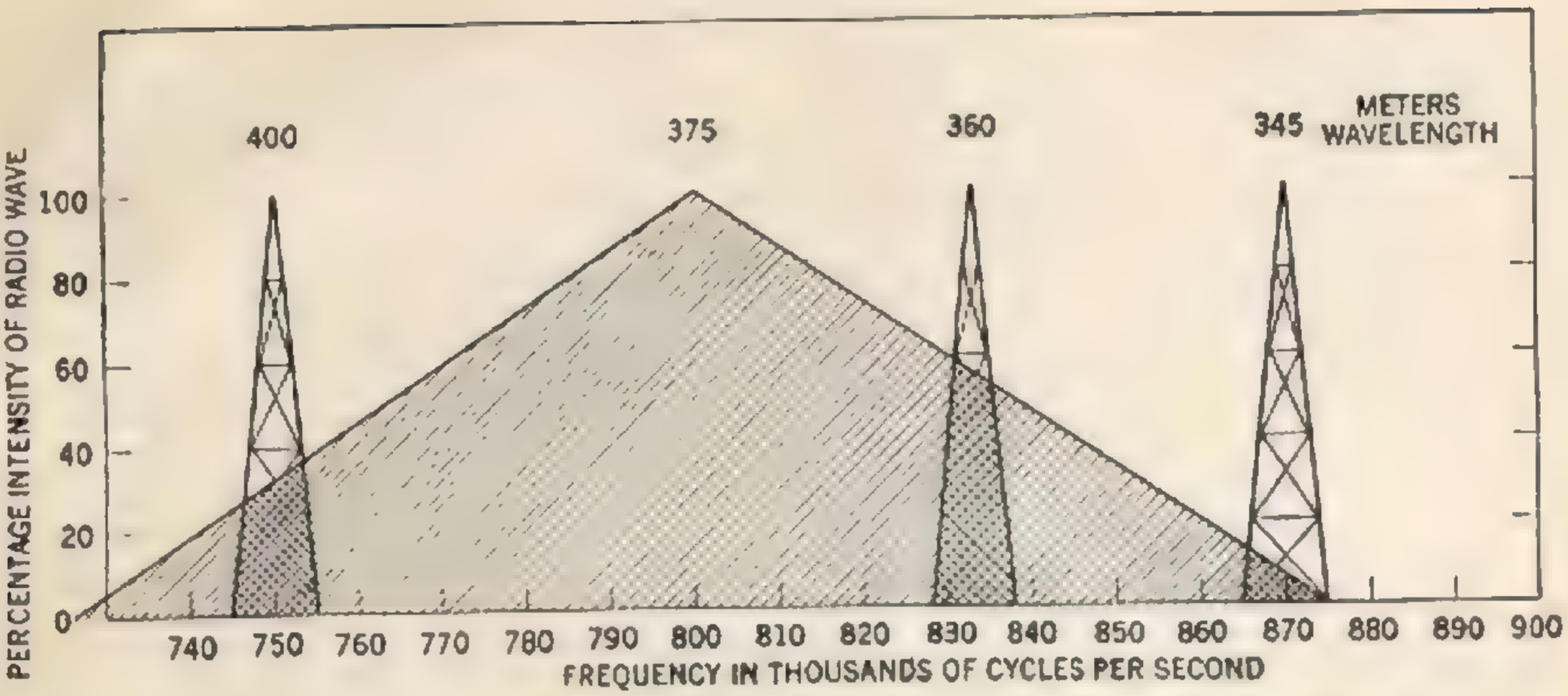
interference troubles is the use by different stations of different frequencies of wave vibration. Radio signals, whether telephonic and in the form of music and spoken words, or telegraphic and in the form of Morse dots and dashes, are carried through space across the earth's surface by waves in the ether. Except for their frequencies or rates of vibration, these radio waves are identical with light waves; they pass through the same ether of space which conveys light waves from the sun to the earth and from a candle to our eyes. Like the flash from an exploding bomb, these radio waves rush outward from a wireless sending station at the almost inconceivable speed of 186,000 miles per second; some of them reach listeners at receiving stations (just as some of the bomb-flash strikes the eyes of onlookers) but the greatest part is lost in space. Unlike light waves, however, the radio waves are completely invisible to us; they are passing through us and around us constantly, but our bodies contain no sensory organs which can detect them. Their frequencies of vibration are so low that the waves cannot produce any physiological effect such as would cause the sensation of light or heat, although the character of the radio waves is exactly that of light waves or heat waves except in the one respect, namely, the number of vibrations per second.

What is the range of frequency of these radio signal waves which we can neither see nor feel? What number of vibrations in one second is too small to set up the sensation of illumination or that of warmth? Curiously enough, these radio frequencies (while far lower in the scale than light or heat) are away beyond the rates of which we usually think. An airplane motor rotates 3,500 revolutions per minute; the middle-C string of a piano vibrates 256 times in one second; everyday radio waves oscillate at the tremendous rates of from 20,000 to 3,000,000 times in one second.

The fact that radio waves may have any frequency from above 3,000,000 to below 20,000 per second opens the way to a great increase in the number of wireless stations which may operate at the same time in the same geo-



A chart giving an approximate idea of the way in which four transmitting stations of high character will distribute their power in space, if they are of equal power and if they are all equally distant from a receiving station. Each of these stations has its total energy confined to a band of 10,000 cycles, their basic wave frequencies being respectively 750,000, 800,000, 833,000 and 870,000 cycles. These frequencies correspond closely to wavelengths of 400, 375, 360 and 345 meters. The accepting and excluding action of a tuned receiver is indicated by the heavy line above the chart. If this receiver accepts radio waves only within a range of 5,000 cycles, or 2,500 cycles above and below its central frequency, no difficulty would be experienced in receiving exclusively from any one of the four transmitters indicated, with no interference from any of the others. In fact, when adjusted to frequencies intermediate to those of the sending stations (for example 770,000 or 815,000 or 850,000 cycles) nothing would be heard



A chart illustrating the changed conditions which would exist if one of the four sending stations radiated a "broad" or poor wave centraling on 375 meters wavelengths (800,000 cycles wave frequency) but spreading its energy over a range of 150,000 cycles. No matter how sharply the receiver may be tuned (the four stations still being assumed to be of equal power and at equal distances), some interference will be found on all wave frequencies from 725,000 cycles to 875,000 cycles. Because of the difference in intensity the signals of the fourth (345 meter wavelength) station could be understood in spite of this interference, but it would be much harder to understand the 400 meter station's messages. So much interference (indicated by the shaded area) would be had when tuned for 833,000 cycles (360 meters) that it would be very difficult to interpret the words sent at that frequency

graphical zone without interfering with each other. This is because receiving apparatus has been developed which is highly selective as to wave frequency. With such instruments it is feasible to arrange matters so that signals will be received from all reasonably distant radio transmitters which operate for example at a frequency of 500,000 per second, but that no signals will be heard from equally distant and equally powerful sending stations using frequencies a little above or a little below this value. Design of receiving apparatus has not yet progressed to the point at which it would be possible to select between transmitters using frequencies so close together as 500,000, 500,001, 500,002, 500,003, and 500,004 vibrations (or cycles) per second. Such exactness cannot be even approximated to-day, but, where radio senders emit waves of reasonably pure character and when the arriving signals are of about the same intensity, it is not difficult to discriminate between wave frequencies which are 10,000 cycles apart, such as 500,000, 510,000, 520,000, 530,000, etc., per second.

It is easy to see that if wireless transmitting apparatus is so designed and adjusted that its radiated waves are quite closely of a single frequency, and if radio receivers are "tuned" so as to exclude waves more than 5,000 cycles above or below the main received frequency a large number of channels for independent communication can be had. One pair of stations can intercommunicate at 3,000,000 cycles per second, another at 2,990,000 cycles, another at 2,980,000 cycles, another at 2,970,000 cycles, another at 2,960,000 cycles, and so on down to the last few pairs at 40,000, 30,000, and 20,000 cycles per second. Each of these frequencies, chosen at 10,000 cycles separation, would constitute what amounts to a radio "private wire" or independent communication channel for the pair of stations using it. Where a division of working time could be made between a number of pairs of stations, all could be operated upon the same wave frequency (which would then become the equivalent of a "party wire" through space). Thus there could be provided room in the ether for a vast number of radio stations to work simultaneously and without interference.

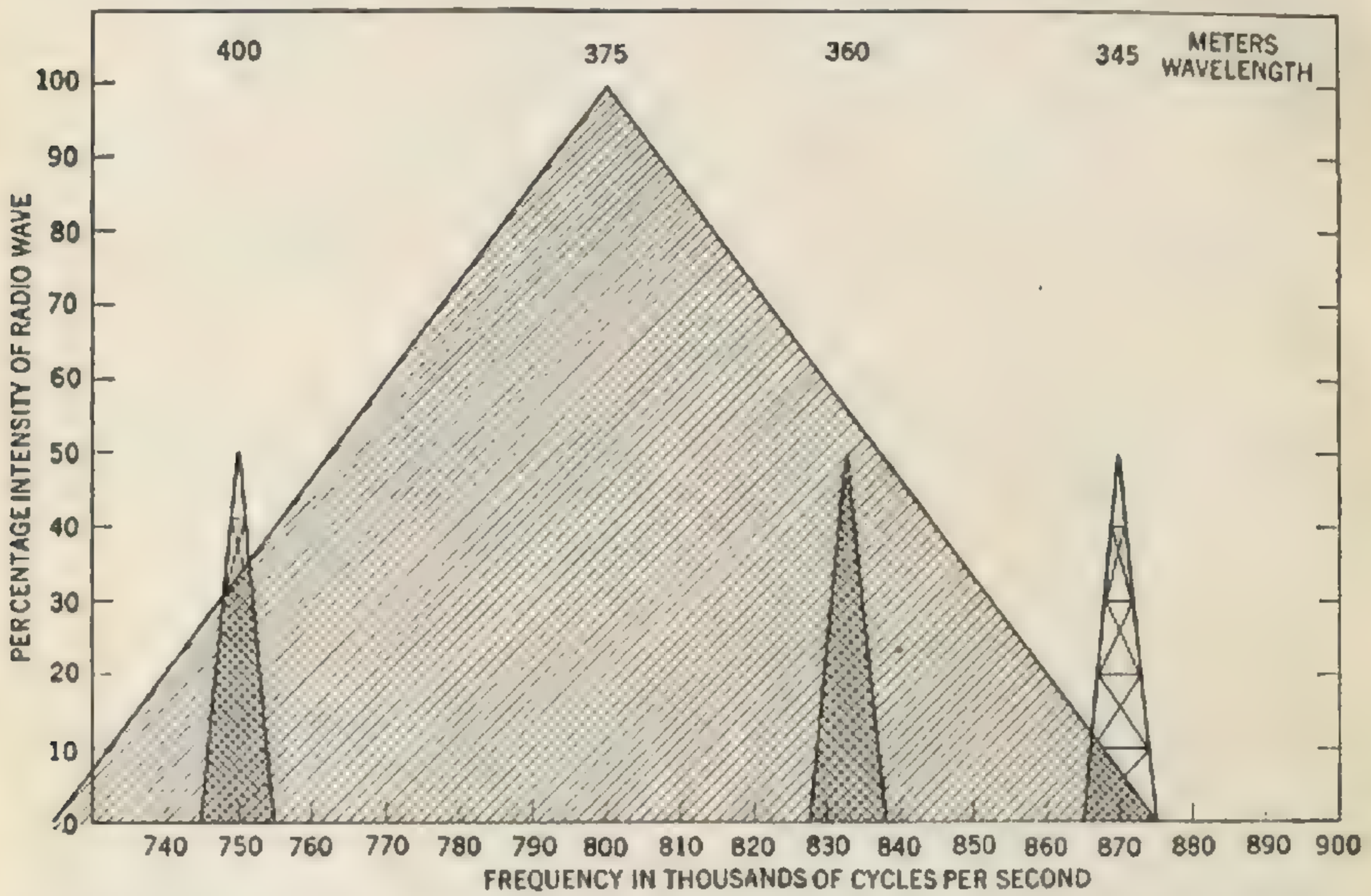
Unfortunately this splendid condition cannot yet be realized in practice. There are three important technical difficulties still to be overcome, as follows:

1. With present-day apparatus the higher frequencies are not suitable for economical and dependable transmission over long distances.

2. Many transmitters now in use, particularly those of the spark type, radiate a large

number (or a wide band) of wave frequencies and so produce interference in receivers sharply tuned to single (or narrow bands of) frequencies.

3. Most radio receivers will select sharply between waves having frequencies a few thousand cycles apart if the intensities of the two



A chart showing, in the same way, the state of affairs which would exist if the interfering broad-wave station were twice as powerful as each of the three others. In this instance the interference would be so powerful over the 725,000 to 825,000 cycle range that the 360 meter station (833,000 cycles) could hardly be heard at all. Even the 400 meter station (750,000 cycles) would be difficult if not impossible to understand. Only at the margins of the interfering wave, as with the 870,000 cycle station (345 meters) would reception be possible at all through the interference

independent-channel condition for radio operations is the restriction of transmitting stations to the modern types which radiate almost their entire power at practically a single basic transmitting wave frequency. This change, which would involve elimination of many spark transmitters from the radio scheme of things (or, at least, their segregation upon wave frequencies widely different from those used by high-grade selective sending stations) would give opportunity for the effective use of sharply tuned interference-excluding receivers. The number of stations which could work independently in a given territory would be greatly increased, for the greatest source of radio interference would be done away with. There is a strong probability that this step forward will soon be taken; legislative inquiries are now under way to determine how new laws may be framed to aid in reducing interference, and this particular remedy is receiving such full consideration that it is likely to be among the first which will be adopted.

waves are equal, but will not exclude interference from a *very intense* signal wave even though its frequency be widely different from that of the weak desired signal.

Because of these difficulties, the number of independent, or non-interfering channels is still quite highly restricted. In fact, it is safe to say that a closely adjacent wireless transmitter of the spark type can effectively prevent reception (despite the use of the best receivers on the market) from a distant transmitter, even though the interfering spark wave has a basic frequency hundreds of thousands of cycles different from that of the desired signal wave.

The greatest single advance which can now be made toward an interference-free multiple-

THE ROMANCE OF THE RADIO TELEPHONE

Being the Story of a Laboratory Toy Which Fell Prey to Unscrupulous Stock Promoters, Became a Scientific Farce, Was Taken Over by Its Supposed Rival, and Turned into a Real Success

By C. AUSTIN

THE story of the radio telephone is a study of extremes. It is the most popular fad at this moment, yet only a short while ago it was the most unpopular invention ever introduced to the public. To-day it is in many good hands for full and sound exploitation; a dozen years ago the wireless telephone, as it was then called, was the prey of unscrupulous stock promoters who used it as a means of prying money away from a gullible public. In its present state of development, it is a partner of the wire telephone; in its pioneer days it was supposed to be a mortal enemy of the wire telephone, and not a few among laity and technicians alike were ready to sound the death knell of the less spectacular wire telephone.

THE HANDICAP OF BEING MARVELOUS

WHAT could be more startling than the idea of talking through space? Imagine a simple device which, at a stroke, could render the present maze of wires, that connects the telephones of the nation into one complete network, more or less obsolete? Consider for a moment the wireless telephone which could be carried about in one's vest pocket and which, at any desired moment, would enable us to speak with some distant person with no other formality than the opening up of a simple loop of wire!

Even in the light of the present radio telephone success, such suggestions appeal to the imagination and sound possible; yet the truth of the matter is that while we can talk through space, the radio telephone has very definite limitations which prevent its taking the place of the present wire telephone. However, some dozen years ago these word pictures were handed about to a credulous public who were ever ready to place their money in what appeared to them to be a second Bell telephone opportunity.

Most inventions, especially if they are of the highly complicated nature of the radio telephone, must spend a long period of incubation in the laboratory, under the constant nursing of a corps of inventors and technicians. Originally, the radio telephone was in good hands in the hands of serious electrical engineers who had discovered the peculiar action of an electric carbon arc when connected with a few turns of wire and what is known as a condenser. A condenser is simply two electrical conducting surfaces, separated by a non-conductor. These conductors absorb and hold an electrical charge; but when the charge becomes too great, the condenser lets go, just as a rubber band which has been pulled to its utmost point and beyond finally snaps and lets go, giving off all the power which has been stored up during the stretching process.

An electric carbon arc, when connected with a few turns of wire and a condenser, sets up a vibrating current, so to speak, in the circuit containing the arc, coil of wire, and the condenser. The electrical engineer calls this vibrating current a high-frequency current. Alternating current, which is used to such a large extent for lighting and power purposes, is also a vibrating current, in that it flows first in one direction, and then in the other, changing its direction of flow sixty times per second in the usual power supply line.

Now, when vibrating currents of sufficient frequency are obtained, it is possible to propagate a portion of these currents through space in the form of invisible radio waves. A system of elevated wires, known as the aerial or antenna, and a connection with the ground serve to impart the waves to the air. At some distant point another system of elevated wires known as the antenna, as well as a ground connection, serves to gather an infinitesimal portion of the radio waves which have been extending in all directions, and to lead them to the receiving

set. It is the purpose of the receiving set to convert the radio energy into some form of energy which comes within the scope of our senses. In the case of transatlantic radio stations, photographic recorders are sometimes employed, so that the waves make their presence known by a wavy line on a band of paper. But in most commercial and amateur receiving stations the waves are converted into sound

SMALL IN STATURE BUT NOT IN ENJOYMENT
Three youngsters of Morrisville, Pa. listening to a concert

and heard through the medium of telephone receivers or a loud-speaking horn.

If the waves are merely modified into short and long impulses, then we have mere dots and dashes of the telegraph code. Each letter is then represented by a certain combination of dots and dashes, the messages being spelled out letter by letter and word by word, except for certain abbreviations. If, on the other hand, the waves are modulated or moulded, so to speak, with the characteristics of certain sounds, such as the human voice or music, then the resultant waves carry inherent sound characteristics which are reproduced in the telephone receivers of the receiving set, instead of the short and long buzzes of the radio telegraph waves.

SHORTCOMINGS OF THE ELECTRIC ARC

ANY one who has had an opportunity of studying the electric arc even superficially must have noted how erratic are its functions. Who does not remember the electric arc lights formerly used in highway and street illumination? These lamps would sputter and flicker almost incessantly. The arc light of a motion picture projector generally kicks up a fuss every so often, causing a change of intensity on the screen. And when these irregularities are coupled up with such a delicate thing as the generation of radio waves, their action is amplified ten thousand fold or more.

At any rate, the pioneers in wireless telephony had the arc to work with. It was to be their generator of radio waves, although one or two workers had constructed special alternating current generators capable of supplying current of very high frequency.

It was the good fortune of the writer to participate in wireless telephony back in 1908 and 1909, with a transmitter of German make. It was a huge affair, about the size of an overgrown upright piano, with a table in front and a tall switchboard at the rear. A series of experiments was being conducted for the United States Signal Corps, with a view to proving the practicability of radio telephony in military communication. The distance to be spanned was some 18 miles, or the air line between Fort Hancock, Sandy Hook, and Fort Wood, Bedloes Island, in the very shadow of the Statue of Liberty overlooking New York Harbor. The high hills of Staten Island intervened, making communication between the two points all the more difficult. By a queer turn of fortune the receiving station was located in the very same radio station building that is now being employed by the Signal Corps for a radio-phone broadcasting station. The main difference is, however, that the present installation works; ours didn't!

Needless to bore the reader with an elaborate description of our pioneer radio telephone. Suffice it to state that it consisted of ten arcs, each arc made up of a copper cylinder closed at the bottom and filled with water so that it wouldn't melt, as well as a large carbon button

pressing up against the copper cylinder and then separated by a quarter of an inch or so to form the arc. Current for the ten arcs, all connected in series, was supplied by a 550-volt motor-generator set. Then there were three meters, indicating the conditions in various circuits. The first part of the programme consisted in taming the ten arcs until the meters stopped their mad antics and their needles or hands, whichever you wish to call them, came to a genteel repose.

A large megaphone mounted on the rear board of the transmitting set was the mouthpiece. One didn't talk, however; one simply shouted. There was little to say, because if we were heard at the receiving end, it was more of a miracle than anything else. So we simply shouted numbers into the huge horn—"One, two, three, four," and so on, followed by "Fort Wood, Fort Wood, how do you get me now? One, two, three, four," and so on again and again, until the meters dropped their dignity and began cutting up once more.

The microphone, or the instrument which transforms sounds into modifications of an electric current, was a renewable affair. The German builders of the equipment, with all their characteristic thoroughness and fine workmanship, made the microphone in the form of simple cartridges which fitted into a holder at the small end of a long but narrow cardboard horn. Each microphone did not last much longer than five minutes, after which it was little more than plain junk. While the writer never knew the exact cost of these microphone cartridges, they could hardly have cost less than $2.00 each. Imagine wasting a $2.00 microphone for every five minutes of uncertain telephonic communication, not to mention the time lost in changing microphones!

CONVALESCING TO THE STRAINS OF RADIO MUSIC

© Kadel & Herbert

A STUDY IN DEDUCTION

WHAT of the results? Absolutely impossible! In all the long months of untiring effort to work over the short eighteen-mile span between the stations, the voice and the phonographic music only got through a half dozen times, and then only for a few moments, so that odd bits of conversation or music were heard by the Signal Corps officers gathered at their receiving end. Even in those days the phonograph was employed for radio telephony.

But all the while certain stock promoters

were reaping a harvest. To them the radio telephone presented an exceptional opportunity. The story of the Bell telephone was to be duplicated, but on a larger scale; radio telephones would be installed in every home for communication purposes; wires and cables would be done away with; everyone would carry a vest-pocket or vanity-bag type of transmitter and receiver for instant use in

THE FIRST TOWER AT WGI
Where the American Radio Research Company did some experimental broadcasting in 1915

calling up any one else and so on. These gentlemen may or may not have believed their own word pictures; but the main thing is that a proportion of the public did. And they parted with their money. Even so, never did a stock promoter prophesy radio receiving sets in most American homes for the purpose of listening to speakers and to the world's best music. That would have have been too much to spring on the public!

Of course there had to be some proofs. There had to be something more tangible than mere word pictures for the public to part with its money. So, certain demonstrations were arranged for between various points. One of these demonstrations took place between two cities. Everything worked to perfection. The results were absolutely wonderful, and nothing of the kind had ever before been realized. The public was enchanted, nothing less; but the true scientists and radio workers were completely baffled. Then, when certain interests were closely investigated, an unpaid bill for the leasing of a telegraph line between said two cities on a certain date came to light. Needless to say, the date corresponded with that of the successful test of the wireless telephone. The inference is obvious.

Another time it was a German company's turn to make a demonstration for the German army. The test was to be between Berlin and another city more than one hundred miles distant. Although nothing of much consequence had ever been done with this particular German wireless telephone system, on this occasion it worked like a charm. An inquisitive German officer, seeking some explanation for the sudden jump in radio progress, not to forget the remarkable clearness and loudness of the received conversation, suddenly discovered a telegraph line running directly between the transmitting and receiving stations. There was no physical connection, however, but nevertheless the radio waves had a nice, easy path to travel between the two stations, which made for such clear and loud reception.

There were other cases, too numerous to mention, some being a deliberate attempt to defraud, and others quite innocently helped along by questionable methods.

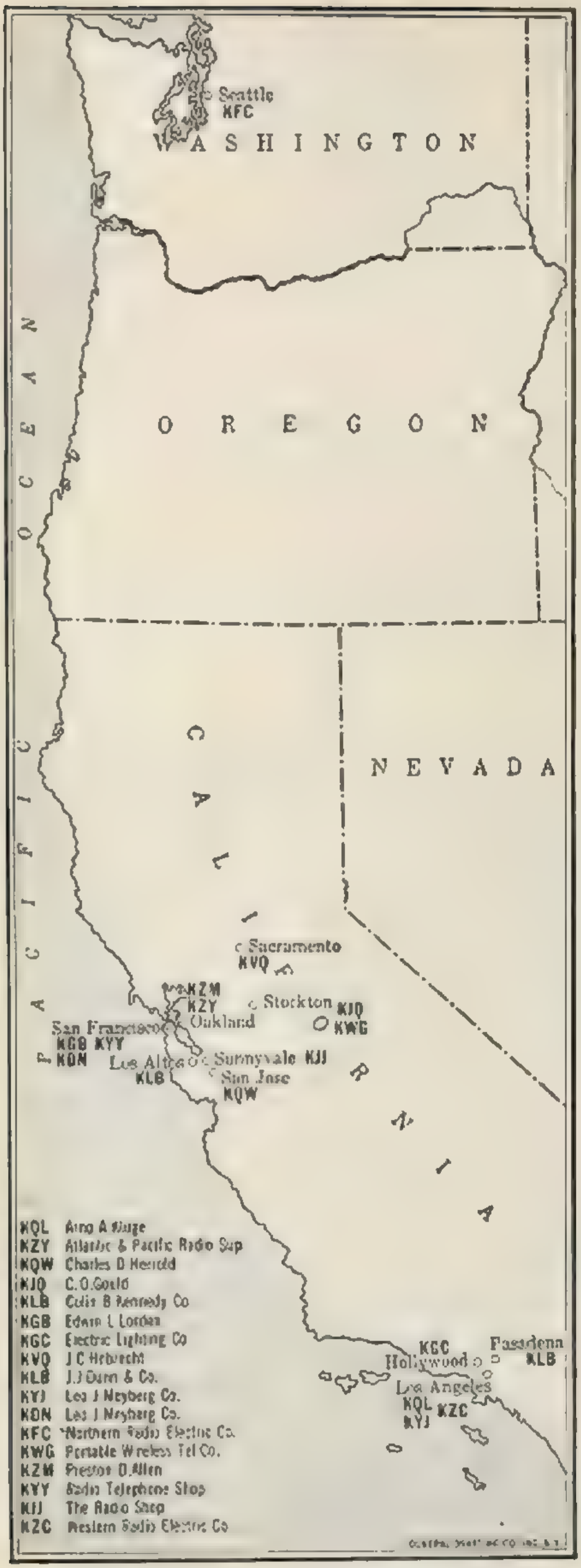
The arc was an impossible means of radio telephony, at least as it was then employed. Many workers gave much time and more money to the problem, and little by little the distances covered were extended into the hundreds of miles. But the results were always of a laboratory nature and nothing of a commercial character ever appeared likely.

WHEN THE RIVAL BECAME A PARTNER

LET us skip over the ensuing years of radio telephone history, with more and more workers trying to harness the balky arc generator and the troublesome microphone problem. We come to Dr. Lee de Forest, an American radio worker, and his development of the little device known as the vacuum tube, which is little more than an electric lamp with a few elements added. Electrically speaking, it is far more than an electric lamp, because it can do more remarkable things than any piece of

THE TALL RADIO TOWERS AT ARLINGTON, VIRGINIA near Washington, which first sent the human voice across the Atlantic

MAIN SWITCHBOARD IN THE ARLINGTON RADIO STATION



PACIFIC COAST BROADCASTING STATIONS

electrical machinery ever devised; but from the standpoint of the layman it is simply a modified form of electric lamp, with a filament that is heated from a cherry red to incandescence, according to the type of tube, a little helix or fine wire or a length of wire bent in zigzag pattern and called a grid, and finally a cylinder or one or more little squares of nickel or other metal, known as the plate.

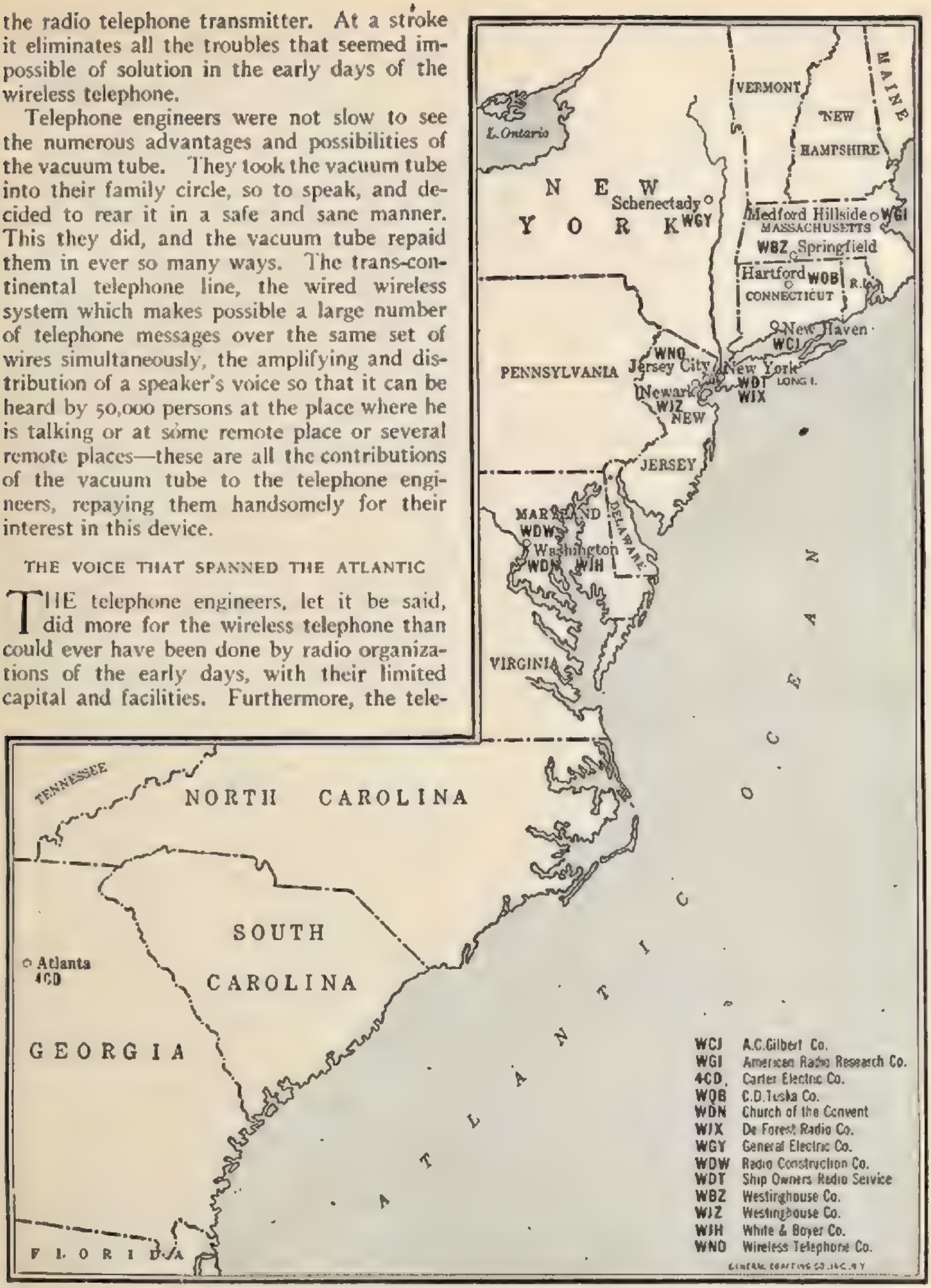
The vacuum tube is the modern Aladdin's lamp. It can do so many things in electrical work that it is virtually an acrobat. It generates alternating current of a wide range of frequencies; and as has been demonstrated, currents of high frequencies are suitable for the generation of radio waves. Thus the vacuum tube, which is positive in its operation, becomes an excellent generator of radio waves. Feed it alternating current, on the other hand, and it rectifies it into direct current—current that flows in one direction only. This feature makes it available as a means of recharging storage batteries off alternating current, and a simple outfit now takes the place of the elaborate storage battery recharging sets of but a few years ago. Again, this feature makes it available as a remarkable detector of radio waves for reception purposes. Feed it a slight fluctuating current, such as a telephone current, and it will modulate or modify a far more powerful current in the same manner; in other words, we have a weak current moulding a powerful current; and since this process can go on through several stages, with each stage handling a still more powerful current, we have a means of making very big sounds out of little sounds, which is what our present-day amplifiers do in radio. It is this characteristic, too, which makes the vacuum tube the best telephonic relay or repeater ever used. It is employed in long-distance telephone communication, so that the voice currents, after traveling through hundreds of miles of wire and becoming greatly attenuated, are brought to the grid member of a vacuum tube and thus serve to control a fresh current starting out on the next few hundred miles. The voice characteristics of the weak current are re-impressed on the strong current, so that virtually nothing is lost no matter how great the distance may be. Again, the vacuum tube, because of its modulating characteristics, is the link between the ordinary telephone microphone or telephone transmitter and the powerful current used for

the radio telephone transmitter. At a stroke it eliminates all the troubles that seemed impossible of solution in the early days of the wireless telephone.

Telephone engineers were not slow to see the numerous advantages and possibilities of the vacuum tube. They took the vacuum tube into their family circle, so to speak, and decided to rear it in a safe and sane manner. This they did, and the vacuum tube repaid them in ever so many ways. The trans-continental telephone line, the wired wireless system which makes possible a large number of telephone messages over the same set of wires simultaneously, the amplifying and distribution of a speaker's voice so that it can be heard by 50,000 persons at the place where he is talking or at some remote place or several remote places—these are all the contributions of the vacuum tube to the telephone engineers, repaying them handsomely for their interest in this device.

THE VOICE THAT SPANNED THE ATLANTIC

THE telephone engineers, let it be said, did more for the wireless telephone than could ever have been done by radio organizations of the early days, with their limited capital and facilities. Furthermore, the tele-



GENERAL BROADCASTING STATIONS ON THE ATLANTIC SEABOARD

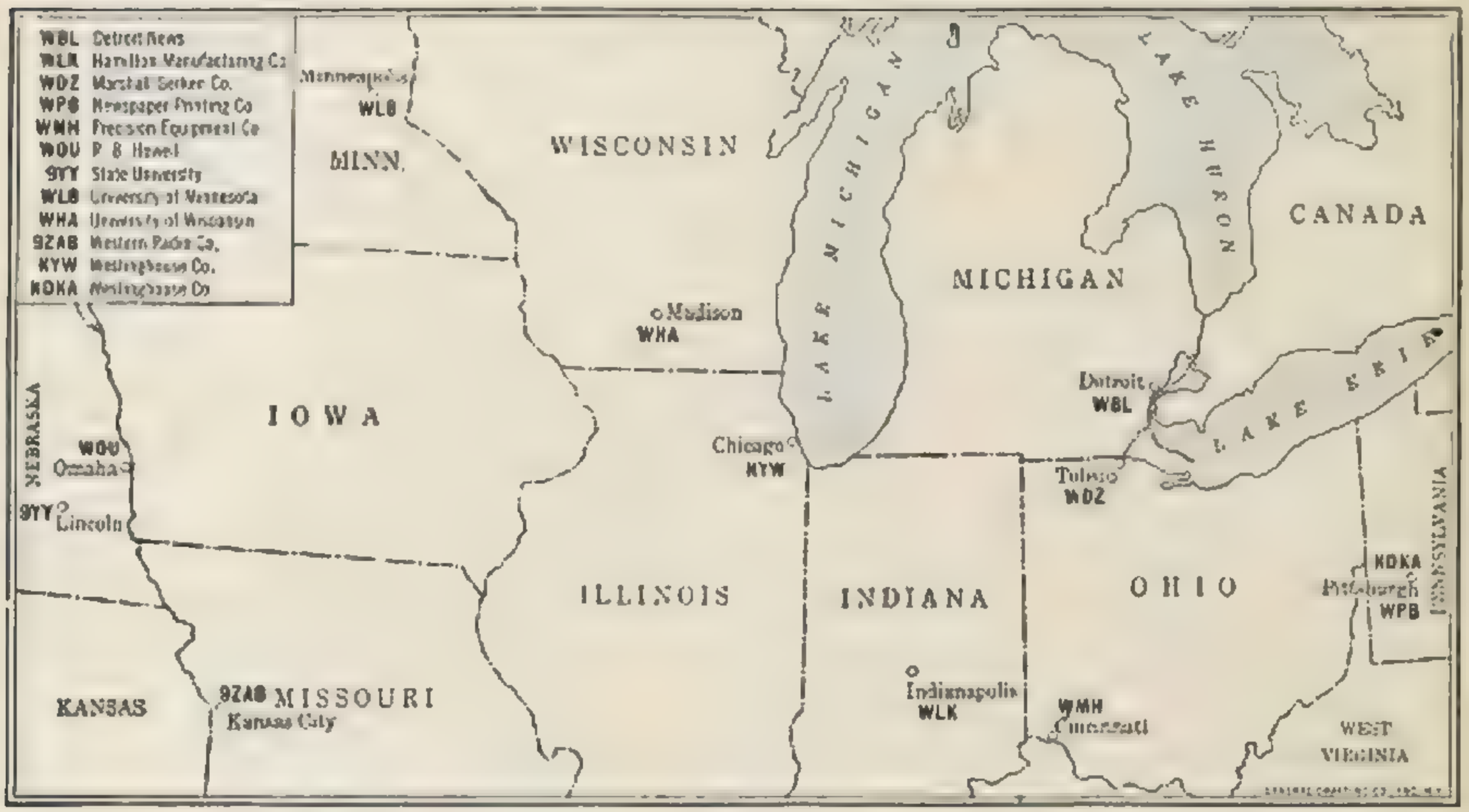
phone engineers worked more or less in the privacy of their laboratories, with little or no news of their progress reaching the public at large. Suddenly, without any warning, it came to light that very definite progress had been made in radio telephony. It was in 1915 that the engineers of the American Telephone and Telegraph Company succeeded in telephoning by radio from Arlington, Va., to the Eiffel Tower in Paris, France, or over a distance of over 3,000 miles. Over three hundred vacuum tubes were employed for the generation and modulation of the transmitted waves. During the same tests the voice carried out to Hawaii, or a distance of almost 5,000 miles.

Came the war, with the urgent need for some form of rapid and positive communication between airplanes and between airplanes and the ground. The best radio talent was applied to the task, and soon little outfits, not much larger than one foot square, appeared in our airplanes for the purpose of ensuring telephonic communication over some fifteen to twenty-five miles. Progress from that day to this has been rapid, for the foundation for practical development was laid by the telephone engineers for all time.

So much for the technical side of radio telephony. But the real success of this invention has been in the broadcasting field, and, fortunately, we do not have to go far back to get to the beginning of this phase of the art.

Probably it is not generally known that the United States Navy is a pioneer of broadcasting, but Navy records and the memories of early radio enthusiasts prove that the Anacostia Naval Air Station near Washington broadcasted music by radio phone for the first time on January 17, 1920. The Navy had, of course, been broadcasting by code for some years previously, but this was the occasion of the first radio telephone entertainment. Commander A. Hoyt Taylor was then in charge of the Anacostia station, then the highest powered radio station in the country with a range of 1,000 miles. A phonograph concert was transmitted weekly, followed by technical information for amateurs, for a considerable period. Navy records show that communications were received in February and again in March, 1920, from St. Louis, Minneapolis, and places in Pennsylvania congratulating the Anacostia station on the strength of its signals.

The Westinghouse organization was the first commercial organization permanently in the



GENERAL BROADCASTING STATIONS IN THE MIDDLE WEST

In the Gulf states there are two stations. WRR, the police department of Dallas, and 5ZU, the State University of Austin, Texas. At Denver also there is station 9AF operated by the Reynolds Radio Co.

field of broadcasting. Under the direction of Mr. J. C. McQuiston it inaugurated its first radio-phone concert through its Pittsburgh experimental station on Nov. 5, 1920. Only a small number of persons heard the musical numbers then sent out by KDKA, as the Westinghouse station is known. These letters, by the way, are the call letters of that station. All stations, whether radio telegraph or radio telephone, have call letters assigned to them by the Department of Commerce which grants licenses for transmitters, just as automobile licenses are granted to autoists and are indicated by the license plates on their cars.

The phonograph was the first source of music, and the operator's announcements sufficed for lectures and talks. The novelty of the feat was sufficient, of course, for the public had not yet been accustomed to the present high-grade programmes. Problems arose over the manner and method of broadcasting, which had to be solved by experiment. There were many times during the first few weeks of broadcasting when the concerts were anything but pleasant to hear. Then, as time passed and, through experience, the operators found out for themselves the kind of phonograph records which transmitted clearly and those which did not, what to avoid in the way of speech, what pleased the public and what did not, and the various other little details which made or marred a radio performance, the concerts became more and more popular.

During the experimental stage, letters began to trickle in from various parts of the country, telling of the reception of music and talks from KDKA. At first, returns were small, and mostly in the way of letters and post cards from established stations, which are always on the lookout for new developments.

Virtually all the broadcasting done by KDKA was pioneering work. For instance, take the case of the radio chapel services, now an established part of every Sunday programme. When the station was first operated, there was no programme developed for Sunday evening. Someone suggested that church services be tried, but there was no precedent for this method of broadcasting church services and it was not known whether the churches would consent to such practice. After some persuasion, however, permission was received from Calvary Episcopal Church of Pittsburgh, to broadcast its services. A district telephone line was installed between the church and the radio station for the purpose

Four microphones were installed in the church to catch the voice of Edwin J. Van Etten, rector, as well as the choir, the chimes, and the organ. The entire services were first sent out January 2, 1921. No one thing ever broadcasted by the radio station has been so popularly received. Letters poured in by the score to the Westinghouse organization telling of the pleasure and the benefit of this new departure in radio.

PREACHING A SERMON AT A DISTANCE OF FOURTEEN MILES

AFTER a time, when the church services were well known to all radio enthusiasts because of the clearness of transmission, the Westinghouse organization was requested by members of the Herron Avenue Presbyterian Church of Pittsburgh to install a receiving set and loud-speaker to take the place of a long absent pastor. This was done, and the church assembled for an Episcopal service. But it listened to a sermon preached about fourteen miles away. This service was a record, a milestone, an epoch-marking event. It was the first time that a metallic horn took the place of a flesh-and-blood minister.

In the meantime phonograph records comprised most of the evening musical programmes. It was decided to do away as much as possible with the "canned" music and substitute real singers and musicians. Talent was not hard to secure for this work, in most cases volunteering its services gladly. Human voices began to come over the radio telephone instead of phonographic music. Again an improvement was scored in radio-phone broadcasting—another milestone. Not satisfied with having merely local talent, the Radio Division of the Westinghouse organization entered into an agreement with the managers of the local operatic concerts with the result that when stars of the first magnitude came to Pittsburgh, their efforts, vocal or instrumental, were and are being broadcasted over a territory of many hundreds of miles.

Not only in opera, but in the world of sport, the radio-phone service has been introduced. Seeking for features that would enliven the evening programmes, it was decided to broadcast, as an experiment, blow-by-blow returns of a boxing match held in Pittsburgh. A private wire was installed from a boxing club to the

radio station, and a man prominent in sporting circles engaged to render a round-by-round version of the progress of the fight. So KDKA was the first broadcasting station ever to send out fight returns. Afterward, the Dempsey-Carpentier bout in Jersey City was broadcasted by a Radio Corporation station round by round.

One by one other features were added, such as the news of the day, weather forecasts, agricultural reports, bedtime stories, addresses by prominent citizens, and so on, making the radio-phone service of value as well as a means of entertainment.

Naturally enough, the success of the Pittsburgh station created such a demand for radio receiving equipment that the Westinghouse organization as well as other firms engaged in manufacturing radio equipment were virtually buried under an avalanche of orders; and they remain buried even to this day. The Westinghouse organization decided to open up other broadcasting stations so as to extend the territory supplied with their radio-phone service. To this end a station was opened on Oct. 3, 1921, at Newark, N. J., known as WJZ. Another station was opened about the same time at Springfield, Mass., WBZ, and still another at Chicago, known as KWY. It is said that more than 300,000 persons hear the Newark programme every evening, and the number is increasing by leaps and bounds.

This Newark station has had the very great coöperation of the Newark *Evening Call*, the first newspaper in the country to have a radio section. Mr. William F. B. McNeary the Radio editor of the *Call* arranged to broadcast the election returns, the results of the football games, etc. He also is the famous "Man in the Moon" who twice a week talks to the children from WJZ.

In the meantime the American Radio & Research Corporation, of Medford Hillside, Mass., which had done experimental broadcasting in 1915, entered the field in the spring of 1921 with a daily schedule for the general public, and from that time on the development of broadcasting has been swift. Newspapers, wireless companies, department stores, private individuals, and others have begun broadcasting activities. Several broadcasting services issue a printed programme for each week, the programme being mailed to all interested persons. It is estimated that nearly eighty broadcasting stations are now in operation throughout the country, and anywhere from 500,000 to 750,000 receiving sets are in use. At a time when most lines of business are badly in want of trade to keep their wheels barely turning over, the radio business is working night and day and yet cannot catch up with the demand. A recent report has it that one radio manufacturer alone will do a business in excess of $50,000,000 for the current year!

BUT WHAT OF THE FUTURE?

AT THIS point we come face to face with the future. We know that the broadcasting service is a success; that the public is buying all kinds of receiving sets, ranging from the little $15 sets for receiving radio-phone service from near-by stations, to the sets worth $300 or more which enable the operator to choose the programme of any one of half a dozen or more broadcasting stations, located within a range of 500 miles or over. The receiving set is readily installed, a simple, single wire antenna of 50 to 150 feet in length, as well as a ground connection to water, steam, or gas pipe, representing all the work required.

But what the laity does not appreciate is the fact that the air, like any highway, can stand just so much traffic and no more. With our present system of transmission and receiving, we can accommodate only a few transmitting stations in the same general vicinity, working simultaneously. To permit more stations to operate is only to cause a hopeless confusion in which one station cannot be heard above the indescribable din. If everyone who wants to operate a transmitter were to be granted a license, no one would have any results and all efforts would be nil. It is as though there were but a single narrow highway throughout the width of these United States, and everyone insisted on buying an automobile. Then we would have so many automobiles for the road space available that practically no one would move and every automobile would become useless.

So it has come to pass that for the safety of radio it is necessary that the issuance of transmitting licenses be limited from now on. The majority of the public want good broadcasting service of the kind that is now being supplied. And since the majority must rule, there must not be hundreds and thousands of radio telephones at work in any one territory messing up the work of the radio-phone broadcasting stations and ruining the art for every-

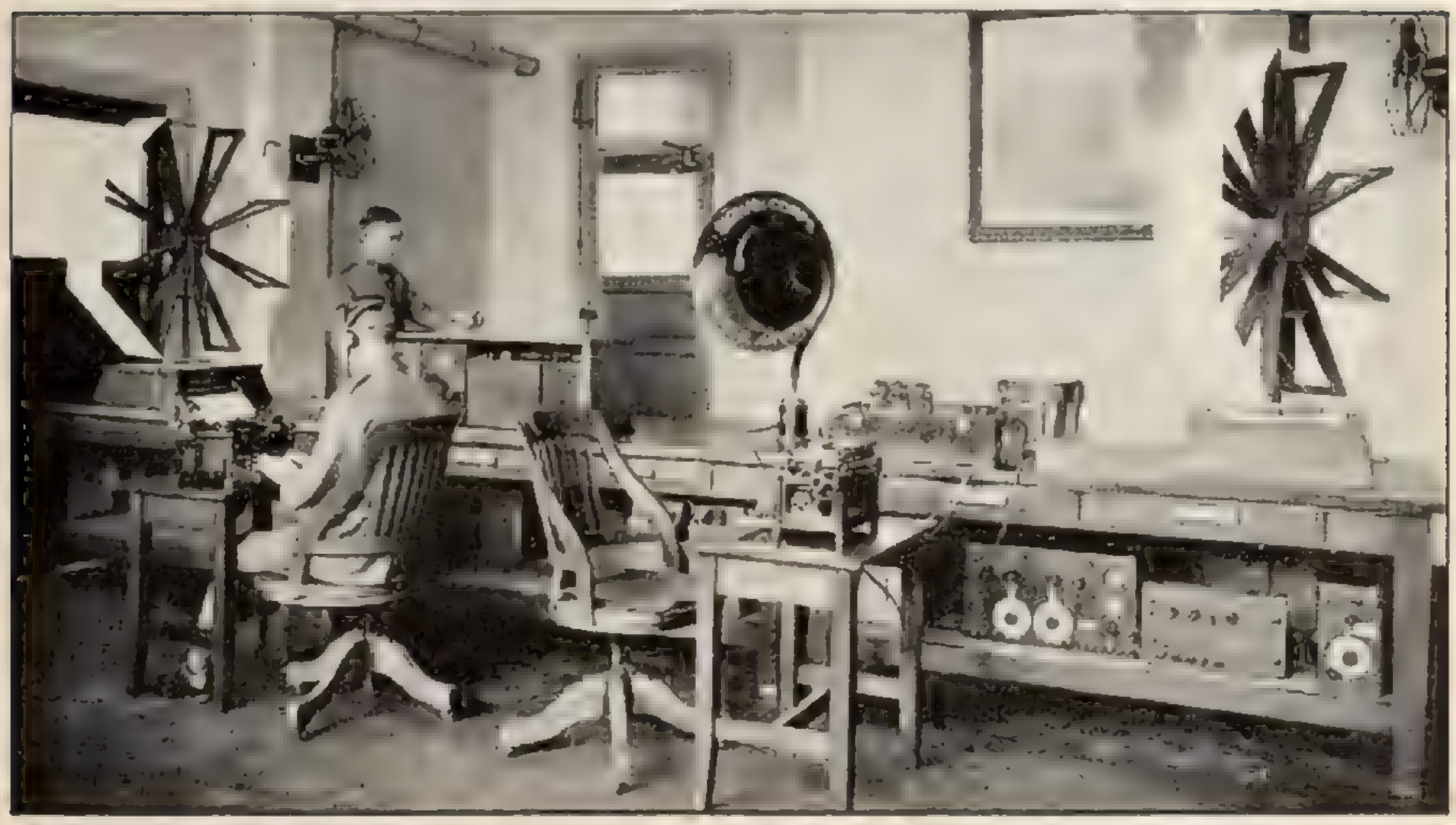
one. The radio-phone is not practical for communication between individuals, because the air will not stand sufficient traffic to enable any number of individuals to use it at the same time. Its main forte, therefore, is in the matter of broadcasting, where it is desired to bring to the attention of a large audience certain facts or reports or even music for their information, education, and entertainment. The wire telephone continues to be the best and only medium for communication between individuals, except in a few exceptional cases, while the radio telephone is the only satisfactory means of spreading facts or music over a wide territory and to hundreds of thousands of listeners. Here again is a touch of romance, for the radio telephone is being developed along lines which were never foreseen by the pioneer workers.

But the radio telephone has made good, after all its years of toil under an unlucky star. It has not put the wire telephone out of business, and never will; it has not come down to the vest-pocket or vanity-case type, as yet, and probably never will; it has not afforded us ready means of communicating one with the other, and never can so long as the space or ether is so limited. But it has united an entire nation into one huge audience which, for the first time in the history of the world, can be addressed from the various broadcasting stations, entertained with the world's best music, and otherwise kept in touch with the affairs at home and abroad. It has annihilated distances, and any citizen may now keep in touch with the latest developments even in distant cities and markets.

RECEIVING STATIONS THAT HAVE REPORTED HEARING WJZ, THE WESTINGHOUSE BROADCASTING STATION AT NEWARK

WHEN UNCLE SAM WANTS TO TALK TO ALL HIS PEOPLE

WHERE THE ARMY GETS THE NEWS OF THE WORLD
European Intercept Room, Signal Corps Radio Station, Washington, D. C.



UNCLE SAM IN RADIO

The Most Extensive Radio Equipment of Any Government in the World. The Signal Corp's Continental Net. The Navy's Shore Stations and International Net, the Work of the Bureau of Standards, the Post Office, and the Bureau of Markets

By DONALD WILHELM

STEERING manless airplanes by radio—the Air Service is doing that. Steering, starting, and stopping a manless ship, by radio—the Navy has done that. And guiding torpedoes through the air from planes, and through the water from planes and from ships, by radio—Uncle Sam is also doing that.

But these are only a few of the things Uncle Sam is doing, by radio!

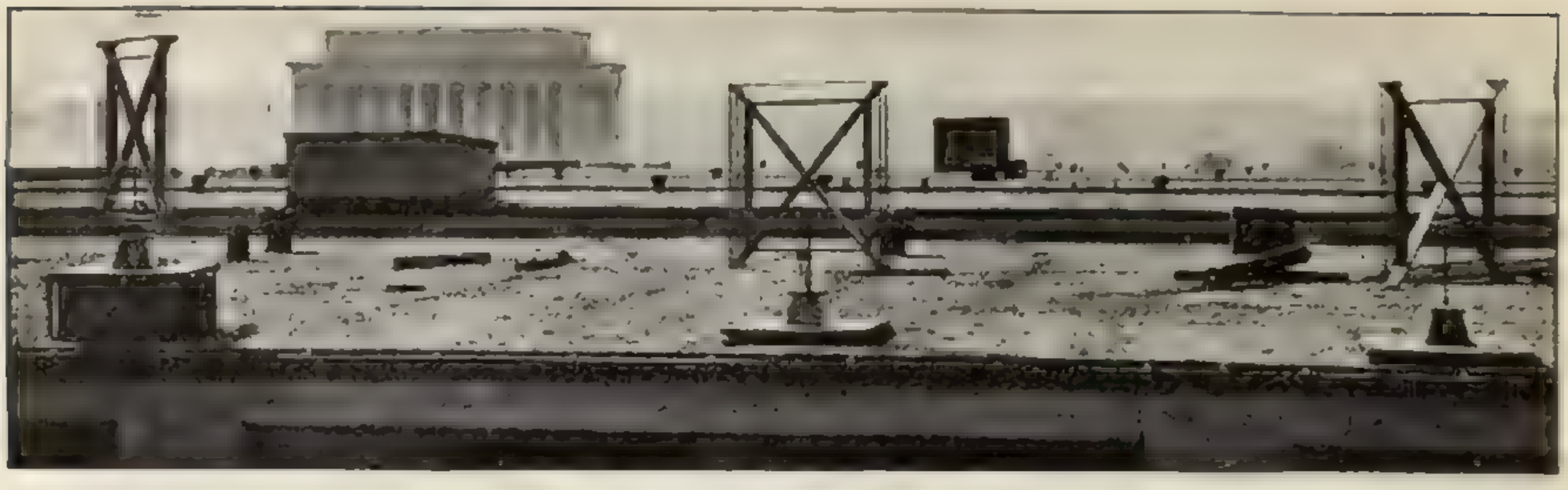
Sending forty telegrams each way along two contiguous wires that at the same time are being used for four telephonic conversations—General Squier, of the Signal Corps, is doing that. And guiding vessels and airplanes to port—no matter what the weather—by radio—Uncle Sam is doing that.

Up aloft Army and Navy planes chat with one another when twenty miles apart, and with land stations when 300 miles away, by radio. I sat in a radio shack on an aviation field, near an amplifier and beside the bride and mother-in-law of an air officer drilling a flock of planes overhead, by radio—and we heard the officer so plainly that the receiver had to be turned off!

Out in the West, Army cloud punchers, clipping the welkin for the Forest Service, report forest fires—even moonshiners!—by radio. And then comes an Army-Navy football game and long before it starts—by the clock!—bets are being settled in far-away Manila, by radio.

But all this isn't all!

The Navy is being run, by radio, and is finding ways not only to detect sounds under water by radio but actually to communicate with submarines under water. It has radio compasses for airplanes, and direction finders,



THE SIGNAL CORPS AERIALS
Receiving loops of the Signal Corps Radio Station, Washington, D. C.

and cables to right and left of which, on the surface of channels of course, ships steer easily, no matter the weather.

Farmers, too, have lost their isolation, because of radio. Via the Post Office Department, the Bureau of Markets and the Weather Bureau have been supplying them with dignified and important information while farmer boys and girls have used the family receiving sets to listen to a thousand things the wireless waves are saying.

It's really incredible in how many ways Uncle Sam is using radio. The Post Office Department, for instance, now administers its Air Mail by radio; and the Lighthouse Service is setting out radio beacons so that from the bridge of his ship a master can tell precisely where he is, by radio.

But the Navy antedated the Lighthouse Service in this work. The Navy has a chain of radio compass stations each manned by five men, along both our coasts and at some points in our island possessions, so that naval vessels and others can make port whenever their captains desire. The Navy has more than fifty of these stations, all the product of the last two and one-half years. During the year 1921 alone, when only forty-six of these stations at most were in operation, they gave 53,344 bearings to 21,622 vessels, with a saving in time and life and property not easily calculated, since it costs $500 and more for many a liner to be forced to lie off port for half a day or so, and blind chance at trying to make port is the parent of innumerable accidents.

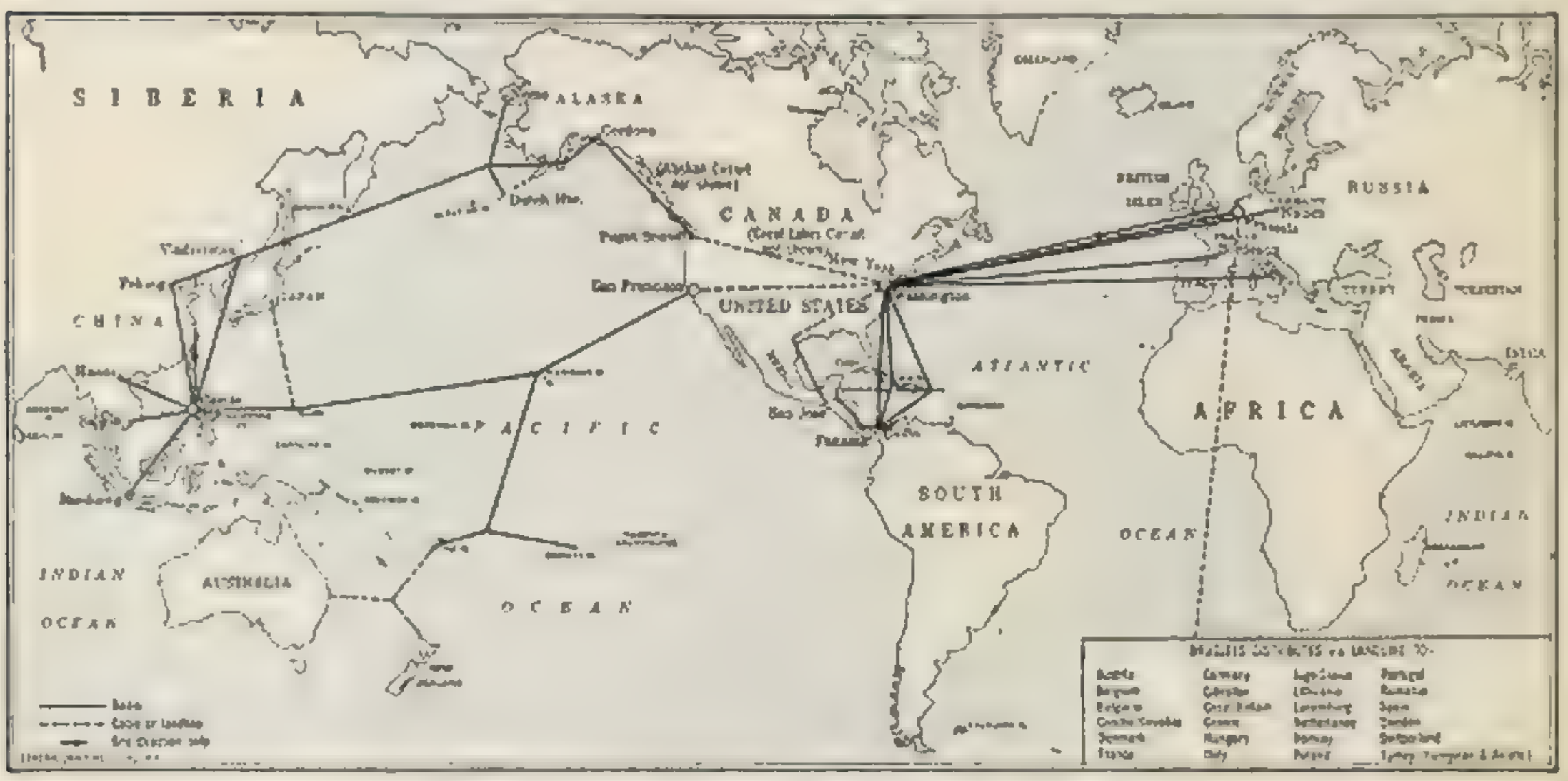
But you must go out with the Atlantic Fleet and live for days in its radio shacks if you want to know anything about the innumerable ways in which the Navy uses radio, because there is no branch of naval en-

HEADQUARTERS OF THE ARMY RADIO SYSTEM
In Washington, the control station of the Army radio net, Captain W. B. Wolverton (in right foreground) in charge

THE ARMY RADIO NETWORK

Which, when completed, will consist of a high power station at each corps headquarters which, with the many lesser stations, makes a network all over the country from which a mobilization call, for example, could reach the whole country simultaneously. The Signal Corps now handles its own business by radio and much other Government business besides.

gineering, with the possible exception of aviation, that has so rapidly developed. The Navy has its wig-wag signals, of course. When its ships are in sight of one another it flashes signals by the blinkers or the heliograph, using a searchlight perhaps. It has its red and white vertical signals too. But when the distance is worth noticing, and frequently at other times, radio is the thing! You'd think the air would be gummed with all this sending and receiving, but system is the word. It has to be so. For radio is now as much a part of the every-day,

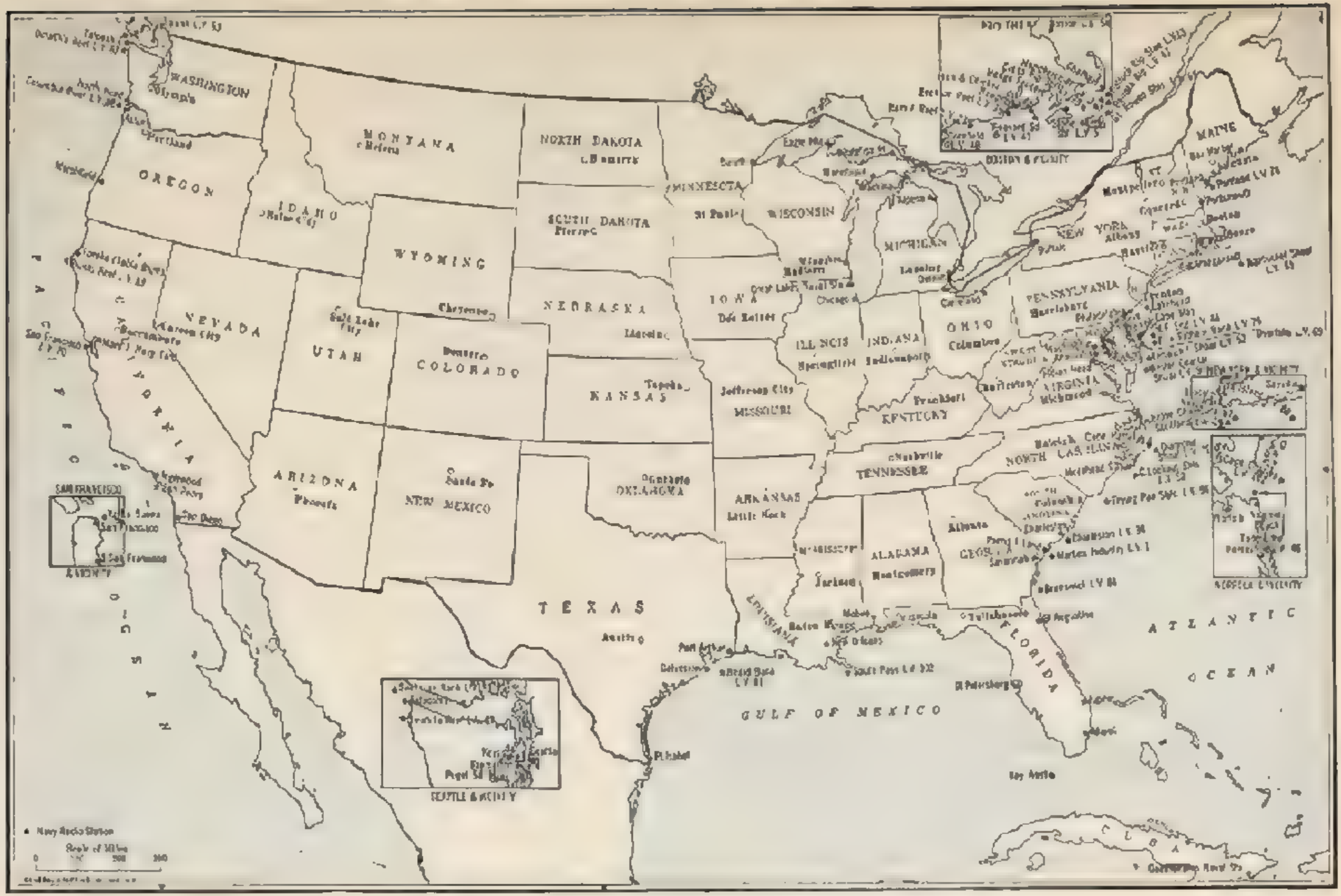


THE NAVY'S INTERNATIONAL RADIO SERVICE

Over the routes shown in this map the Navy handles news and commercial messages as well as its own departmental and other Government matter

every-hour, every-minute routine of the Fleet as the use of engines and rudders. Not only for emergencies, not only for maneuvres, not only for all sorts of general utility work does the Navy use radio; rather, the Navy is simply run by radio. The Secretary of the Navy, let us say, wants to send word via an all-Navy radiogram to all the 650 naval ship stations, all the 102 naval airplane stations, all the 180 shore radio telegraph stations? Very well, he dictates his message, in a trice someone snatches it, in code, down the corridor, and, pronto! it is leaping tell-tale up and down and round the world. And it's just about as easy for him to reach the 1,037 Shipping Board stations and every other thing, almost, that floats. Or, say, you have an event like the bombing experiments in Chesapeake Bay last year. There, one day, a flock of bombers set out from Langley Field to sink the target—and promptly sank it. Meanwhile, another flock started from its base, a hundred miles away. Then, out from the radio guard ship that day, snapped the order to the leader of this second flock of planes, "Target sunk. Return to base." The leader got the message, barked his orders into a radiophone, and in perfect order his planes turned back. Again, one day, while the experiments were on, the *Shawmut* caught a message from Langley to the planes, "Drop your bombs and return to base. Storm coming up the Coast." And again, one afternoon, when a bomber was circling overhead, waiting for the inspecting officials to leave the target, it flashed its message down to the radio guard ship, the *Shawmut*, "Unless you leave the target within fifteen minutes we must return to base because our gas is running low." They left!

But such bits of administration as these are commonplace to the Navy. It has a good deal more than $25,000,000 invested in radio. It is sending a good deal more than 8,000,000 words a month by radio. It is doing $10,000,000 worth of commercial radio business annually—business at the rates of the commercial companies which they themselves cannot handle. Yet the important thought is this: That our Navy has without question the most comprehensive and effective net of its trans-



THE NAVY'S SYSTEM OF RADIO STATIONS IN THE U. S.
This does not show the compass ranging stations for guiding ships into port

oceanic kind in the world. Japan, for instance, in the nature of her possessions, has nothing comparable—actually could not reach by her own radio her merchant ships in remote corners of the world. France's trans-oceanic key strength is mainly that of the Lafayette station, now the most powerful in the world, which our Navy built during the war, which can reach round the world, if conditions are quite right. Italy can reach our eastern Coast, hardly more. Germany is practically out of the running, though she retains two large stations, after having given up Togoland in Central Africa to England, and Tuckerton and Sayville to the United States, since they are on our territory, and various and sundry other possessions to other Allies. So it comes to this again, that the British Empire and Uncle Sam, in the ether as on the seas, come nearest to being on a parity. Yet it is no exaggeration to say that, though the British Empire has available, if it chose to use them, more ships than we have and quite a good deal larger spread of land possessions, still her contemplated Imperial Radio Chain does not as yet favorably compare with the U. S. radio net as a whole, even if we do not include our purely commercial companies—the Federal, in the Far East, and the Radio Corporation of America, which is spreading out through and across Europe and elsewhere.

Our Navy built the first high-power continuous wave station, on the Canal Zone, in 1914. It has blazed the way in many other directions. Its net can broadcast, and as a matter of fact does, everywhere up and down the seven seas.

And now comes the Army with a land net that for solid thoroughness and scope is also unique.

The writer is able for the first time to outline the scope of this net, which for the most part will be in full operation before this article can be read.

The Army, you see, has nine corps areas, since its reorganization following the war. Its radio net will cover all these areas, with its control station in Washington, and all our fourteen aviation fields and all our artillery and other posts will be tied into this net. Ft. Wood, in New York, for instance, is the headquarters of the Second Army Corps, and has in its area the radio stations at West Point, Mitchell Field, Camp Dix, Camp Vail, Rariton Arsenal, and Fort Hancock, all of which, in turn, use radio for different local as well as larger purposes. Again, in the same way, the Third Army Corps, with headquarters at Ft. Howard, Baltimore, Md., controls Fort Monroe, Langley Field, and the Aberdeen Proving Grounds; while Ft. McPherson, at Atlanta, Ga., headquarters of the Fourth Army Corps, includes the stations at Camp McClellen, Ft. Barrancas, etc. From Ft. Benjamin Harrison, at Indianapolis, Ind., the Fifth Army Corps reaches out through the stations at McCook Field, Camp Fairfield, and Camp Knox; while the Sixth Army Corps, Chicago, has in its net Camp Grant, Ft. Sheridan, and Ft. Brady. Ft. Leavenworth, Kansas, Jefferson Barracks, and other stations, are in the net of the Seventh Army Corps, with headquarters at Ft. Crook, Nebraska. The Eighth Army Corps, at Ft. Sam Houston, Texas, has Ft. Brown, Ft. McAllen, Ft. Ringold, Ft. McIntosh, Ft. Bliss, and Ft. Huachuca. And the Ninth Army Corps, San Francisco, includes the Presidio, Ft. MacArthur, Ft. Douglas, and Ft. D. A. Russell, at Cheyenne, Wyoming.

It is worth noting too that our fourteen major aviation fields, though comprehended in the Signal Corps net as a whole, nevertheless constitute an alert net of their own, so that they can make the fullest and most prompt use of meteorological and other special data.

These Federal agencies, all that have been mentioned here, are by no means all that are using radio.

The Coast Guard, part of the Navy net, employing the Navy waves, uses radio for all manner of purposes—for administrative work, for relieving distress, for warding ships off from the location of icebergs that come cruising down our Atlantic Coast periodically, and for a score of other purposes.

The Prohibition enforcement authorities are also using radio here and there.

The Public Health Service is broadcasting health data by radio, via the Anacostia Station, near Washington, of the Navy, and heretofore via wave length 425.

And then, too, not only is every Federal Department using radio somewhere or other, but Uncle Sam is forging ahead experimentally. The Army Signal Corps, the Navy, the air services of both arms of the service, and other agencies are doing interesting and promising laboratory experimental work of one kind and another; the Air Service of the Army, for instance, has planes equipped experimentally

with radio instruments of one kind and another, and the Navy has a radio experimental ship, the *Ohio*. Then, too, the Post Office Department has done a good deal of experimental work with radio in relation to Air Mail planes. But the Bureau of Standards, of the Department of Commerce, which department controls the licensing of sending stations and the inspection of all ships carrying more than 50 souls, is probably doing as much as any other Federal agency, in certain fields at least, to develop radio and its manifold uses to the full.

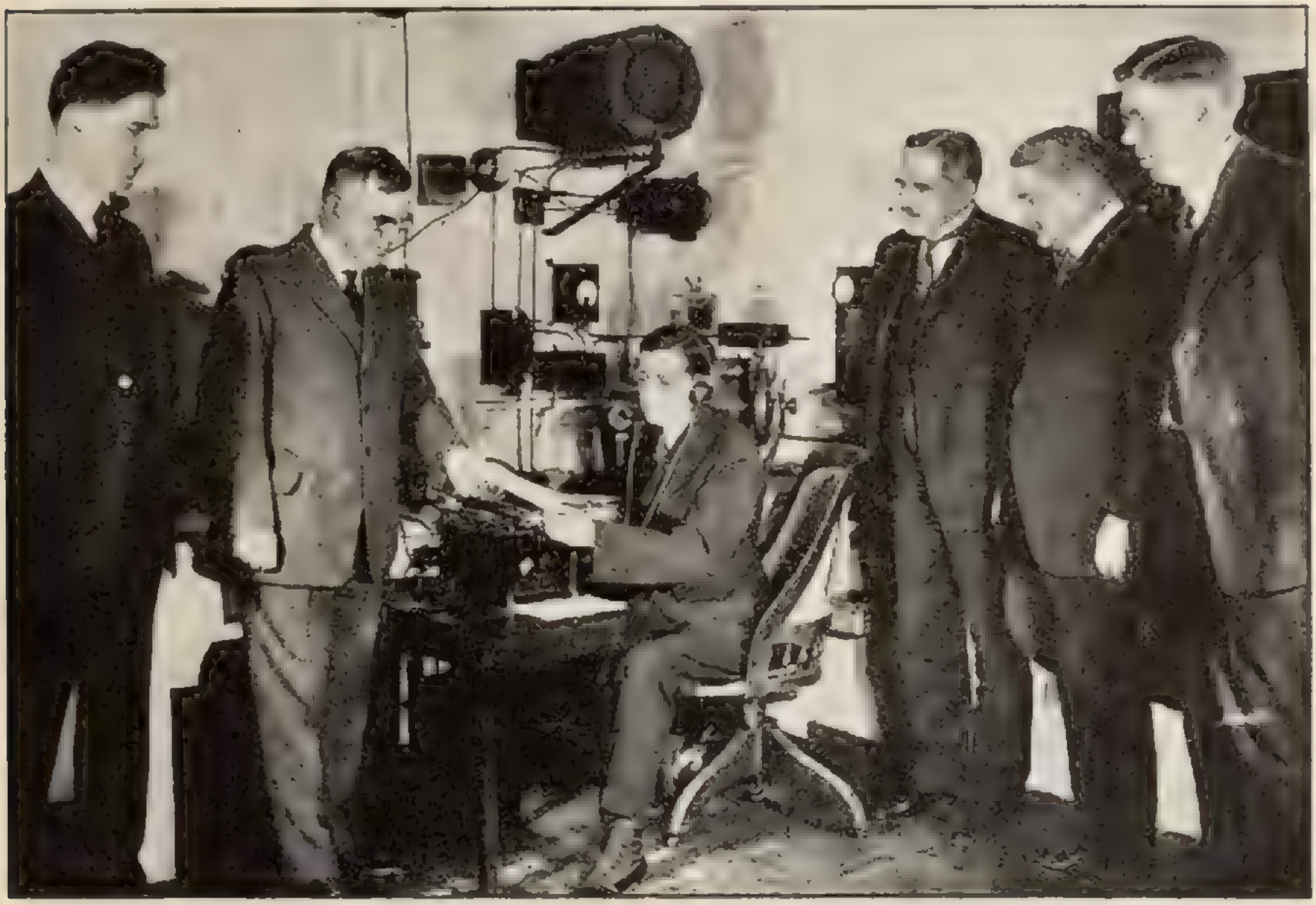
Now, at last, there is a larger thought—take it as a bit of prophecy, if you will! It's this:

Not only is the time impending when the Navy will be run by radio and when the Army will be run by radio, but when the Federal Government will do all or much of its telegraphic business, along with vast schemes for public enlightenment, by radio.

The figures are in—it's a lot cheaper than the use of leased wires. Besides, above all else the Army, and the Navy must keep their nets alert. Those nets include, of course, trans-Continental as well as trans-oceanic service, and the Army corps stations, like most of the stations of the Navy, are equipped or can readily be equipped for broadcasting by phone as well as Morse code, or both.

And it would not even require legislation for the most part, for Uncle Sam to use radio for all practicable administrative purposes. Thus the Army and the Navy are already in agreement: The Army agrees to handle for the Navy all its deferred trans-Continental business, while the Navy agrees to handle all the Army's rush coast-to-coast business; the Navy handles the Army's trans-oceanic business, while the Army handles the Navy's inland business with recruiting stations, for instance. Both the Army and the Navy can, or could, double their traffic capacity—there is no question on that score.

Why not use Uncle Sam's unparalleled world-wide radio net, for all it's worth?



OPENING DAY OF THE RADIO STATION IN THE POST OFFICE DEPARTMENT

Left to right, J. C. Egerton in charge of the station, Secretary Wallace of Agriculture, (then) Postmaster General Hays, Charles F. Marvin, Chief of the Weather Bureau, S. W. Stratton, Chief of the Bureau of Standards, W. A. Wheeler, Director of Markets

"SPACE RADIO" AND "LINE RADIO"

By DR. LOUIS COHEN

IN SPEAKING of radio we generally think "space radio," the usual method of intelligence transmission by means of electromagnetic waves radiating in all directions from a central source, an antenna. In contradistinction to this form of radio, another form, "line radio," electromagnetic waves guided by wires, the invention of General Squier, is rapidly coming into wide use. These two forms of radio have many things in common yet fill different public needs in the matter of communication. In both methods the engineering practices and methods are identical; high frequency currents are employed, and the same instrumentalities for generating electromagnetic waves, tuning, modulation, detection and amplification are utilized. The methods, however, for transmitting the energy from the transmitter to the receiver are different. In one case the energy is radiated in all directions, broadcasted, and everybody who so desires is at liberty to receive the signals, while in the other case the energy is confined to a limited region and can be received only at one or more definite points.

DR. LOUIS COHEN
Consulting engineer, Signal Corps, U. S. A.

At this time of a growing popular interest in "space radio" and increasing demands for the broadcasting of news and information, requiring a greater and greater number of wave channels to carry the broadcasting traffic, it may be well to consider the great possibilities of "line radio" to take care of all individual communications, leaving all the available wave channels in "space radio" for communication between mobile stations, such as ships and airplanes, places inaccessible to wire lines, and broadcasting. By the use of "line radio" the existing telephone and telegraph lines may be loaded up by multiplying the number of messages carried on any single line so as to take care of all possible public requirements for personal communication, and in a very economical manner at that.

It must be remembered that the number of wave channels available for "space radio" are limited. Every communication monopolizes, for the time being, a definite width of wave band and should, therefore, be employed only for such services as will be for the greatest possible public usefulness, or for such other services as cannot be accomplished by the old methods of line telegraphy and telephony or "line radio." Broadcasting is a service that can be accomplished only by "space radio" and the use of "space radio" should be limited as much as possible to that service. On the other hand, in "line radio" the number of circuit channels can be increased almost indefinitely and always kept up to capacity to meet all public needs for individual communication, personal or business. "Space radio" and "line radio" are two aspects of the same art, both utilizing the same methods and instrumentalities; the developments and improvements in one are generally applicable to the other, but they supplement each other in the matter of use. In considering any new regulations in the matter of wave distribution service, etc., it would be well to keep in mind the possibilities of "line radio" for individual communication, reserving "space radio," to a very large extent at least, for broadcasting.

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HERBERT C. HOOVER, SECRETARY OF COMMERCE AND RADIO

This is not his official title, but the Department of Commerce is authorized by law to regulate radio traffic in all its forms, and in this capacity it is going to come into immediate contact with the whole public as the whole public becomes radio receivers. At the opening of the Radio Conference Secretary Hoover made the following statement: "We have witnessed in the last four or five months one of the most astounding things that has come under my observation of American life. This Department estimates that to-day more than 600,000 (one estimate being 1,000,000) persons possess wireless telephone receiving sets, whereas there were less than fifty thousand such sets a year ago. We are indeed to-day upon the threshold of a new means of widespread communication of intelligence that has the most profound importance from the point of view of public education and public welfare. The comparative cheapness with which receiving stations can be installed, and the fact that the genius of the American boy is equal to construction of such stations within the limits of his own savings, bids fair to make the possession of receiving sets almost universal in the American home"

WANTED: AN AMERICAN RADIO POLICY

The Problem Confronting Our Interests, Amateur, Commercial and Governmental

By DONALD WILHELM

THE United States is in immediate need of a radio policy, and this fact was the first to confront the Washington Radio Conference, where the opinion on this question was unanimous.

And why?

Said some of the radiolytes present, "The amateurs—they're too much with us!" Answered Mr. Godley, of the American Radio Relay League, and others, "We're tired of being more or less unwittingly misrepresented, we amateurs!" Said others, "Too many jazz hounds!" Answered some more, "And too many canaries." Agreed everybody, "The air is in a mess." Remarked Chairman Hoover, who called the Conference, "Yes, this is one of the few instances where the country is unanimous in its desire for more regulation." He added that, clearly, what is needed is an ether policy.

And who should form the policy and don uniform and wield the big stick of its enforcement?

Uncle Sam, of course.

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CONGRESSMAN WALLACE H. WHITE, JR.

Who is making a special study of radio conditions and possible radio legislation

To begin with, then, we can put down one very tangible and meritorious result of the Conference: Thanks to the phenomenal popularity of the radiophone in the main, policing of the ether is imperative; Uncle Sam is clearly the only one who can do the job; and so far as non-governmental radio work is concerned, it is now plain that the wholly inadequate authority, force, and funds of the Bureau of Navigation must all be increased.

But there are other results already achieved by this Conference called, at the request of the President and Cabinet, by Mr. Hoover.

Mr. Hoover, himself, indicated some of them. He said that the Conference, with a view to affording the greatest good to the greatest number of Americans, had, clearly, made progress by enlarging and defining the ether rights of the public and the amateur, and by working out and recommending the largest possible permutations of available wave bands with respect to existing priorities, zones, time factors, and the like.

"The Conference," said Dr. S. W. Stratton, Director of the Commerce Department's Bureau of Standards and chairman of the Conference technical committee, "has already gone a long way in settling what purposes can and should be served by radio and what purposes can still best be served by other means of communication. It established a tentative classification of the agencies that are invaluable in the radio field. It has made progress in the allocation of the channels of communication, i. e., the wave lengths. And it has suggested constructive modifications to be made in the present radio laws, the last of which was passed in 1912 and is now inadequate because of the pressure of later developments."

Also, the Conference made clear that there probably can never be private property rights maintained in the ether. Then, too, it perceptibly diminished the zeal that, at first, some organized groups displayed in gunning for exclusive rights to bands of waves (which rights could be capitalized to the tune of millions of dollars). Moreover, the Conference has made clear that squabbles over wave bands in Uncle Sam's own official family must be settled out of court—that is, the Governmental agencies using radio must forthwith hold a conference of their own, settle their own differences, and establish, perhaps, some kind of a permanent inter-departmental body or board to settle governmental radio problems as they arise. Also, one of the most profound inferential results—and the inferential results of this Conference, like, say, the Washington arms conference, perhaps quite equal in importance the direct results—points to a powerful lot of fuss and fume that the United States delegates are now certain to make at the forthcoming international conference in Paris, to which this Conference is in a sense the preliminary.

But, first, let us glance at some interesting points of view now, rather for the first time, hauled out into the open.

For the American Telephone & Telegraph Company, for instance, Colonel Griswold pointed out that radio is now being used and for every reason should continue to be used for linking up with main lines of communication remote areas or islands, such as Catalina Island, which do not warrant the maintenance of cable or land lines. He described, interestingly, how, even now, in some of these localities a toll subscriber gaily talks over a phone without realizing that he is bridging a goodly space by ether, with wires at the ends only, while enjoying continuous

service. And he stated that the A. T. & T. is making plans to enter the broadcasting field, as a public service.

L. R. Klum, representing the Westinghouse Company, cheerfully volunteered the information that his company had entered into the broadcasting business as a sales device. When Mr. Hoover asked him if he expected the sales of receiving equipment to continue and if there is not likely to be a "saturation point" Mr. Klum said, "I don't believe it. There is no saturation point on automobiles, for instance. We have found a steady increase in sales and we don't anticipate any drop if the quality of the broadcasting is maintained." He also said, "There is a limit to the number of broadcasting stations that can operate successfully. So there must be some regulation and possibly some limitation of the number of these stations. Fifteen could probably cover the country."

The trend of the whole Conference looked to larger and larger public use of radio, and before the sessions had gone far the trend toward enlargement of the supreme rights of the public became apparent. Here, on one hand, you found representatives of city police departments emphasizing the necessity of certain waves being reserved for police use between municipal police stations and patrolmen, motor boats, bicycle police, police automobiles and airplanes, and fire and other moving apparatus. Here, again, you found large city newspapers shown as supplementing their news columns with ether information, even entertainment. Next, emphasis was laid on the undesirability of ether advertising, by department stores or other agencies. Then, also, there were complaints against the selling of inadequate apparatus, such as receiving sets of insufficient range in wave length. Instrument makers had their pros and cons. The amateur repeatedly had his innings. The supreme importance of ship service was hammered home. The appetite of the public for broadcasting of health information, market information, all kinds of information, was dwelt upon at length. Also, often, you found allegations made that this or that company was trying to corner the sale of tubes or other facilities. There was talk, even, of censorship, of the necessity of competition between broadcasting stations in given areas, as between newspaper sending stations, for instance; and predictions, prophecies, and more and more stress on the needs and desires of our old friend, the people. Withal, you got, from sitting in on the Conference, the picture of a great instrumentality coming of age—and as a matter of fact radio is just about twenty-one years of age! It was as if everyone agreed, "Now here's a great big boy of great big stature rising up in our midst. We don't know all about him, yet, but we've got to make room for him. So it's a question of ways and means, to please the people and give us all a good square deal."

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DR. S. W. STRATTON

Chief of the Bureau of Standards, who was chairman of the technical committee of the Radio Conference which made recommendations for a national radio policy.

Now, by contrast, the last committee appointed by the Secretary of Commerce, Mr. Alexander, to deal with radio and its problems, was inconsequential, from the point of view of public interest.

And when one says that, one gambols ahead in apprehension of the next international conference. Because it's all too evident that no other country in the world has, in the nature of its areas and native problems, the needs and opportunities for radio that we have, and no other nation has even approached in develop-

ment our own amazing interest in phone and Morse Code broadcasting.

So a bit of background is in order:

The regulations now governing international radio communication were drawn in 1912 at the London Radio Telegraphic Convention, and were promulgated by President Wilson on July 8, 1913. Next, in Paris, during and following the war, there were various international radio conferences between the military and naval representatives of the Allies, which conferences dealt with wave allocations and scores of other technical problems, and, of course, had no concern with public broadcasting of the kind that is now our favorite indoor sport.

Next came a preliminary Inter-Allied conference in Washington, in 1920. At that conference were the five principal Allied Powers. It covered the subject of communications generally, including not only radio but wire and cable communication too, and in that respect it made a departure.

Now, mainly in preparation for this preliminary conference, which was to formulate a programme for the main conference to meet in Paris in June, last year, in March, the previous year, Secretary Alexander appointed a committee which held meetings, much as the present conference has been doing, and threshed out wave and other problems. It also drew up its recommendations. These were published in a Government document and the committee expected them to be pushed by our Government, since they had been unanimously adopted and were approved by the War, Navy, and Commerce departments.

But at the 1921 Paris International Conference the American report was not made the basis of action by the American delegation. It was vigorously supported, in the meetings of our delegation by some of our delegates, notably Dr. J. H. Dellinger, against radically different recommendations by the military and naval representatives composing the majority of our delegation. The upshot of the situation was that our own commercial and private radio interests came from the Paris Conference disgusted, emphatically of the opinion that it had been a military show with all too few privileges accorded commercial and private aspirations. And the disappointment and wrath of our commercial and private interests was all the more intensified because an agreement on a Government policy had supposedly been reached on all controversial matters through the deliberations of the Alexander Committee that had met early in

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AT THE RADIO CONFERENCE IN WASHINGTON

Reading from left to right in the front row Secretary Hoover, Mr. Will Hays, then Postmaster General, General George O Squier chief signal officer U. S. A., Congressman Wallace H. White Jr., Swager Sherley formerly chairman of the Appropriations Committee of the House of Representatives, the first radio lawyer. In the second row behind Secretary Hoover is Dr. Louis Cohen, in the doorway between Postmaster General Hays and General Squier is Mr. E. H. Armstrong the discoverer of the "feed back" circuit, and the second figure to his left is Dr. Alfred Goldsmith, the Secretary of the Institute of Radio Engineers

1920 before both the preliminary and the full international conferences.

Now the United States finds itself confronting another international conference, fully aware that our commercial and private interests were disgusted with the last and for every reason hope for better results from the next especially because of the promise of the naval holiday arranged for by the arms conference. Meanwhile, too, our commercial interests have enormously expanded in scope and are steadily reaching out and up and down the world. And meanwhile the amateurs are crowding the commercial companies for more and larger opportunities, while the commercial interests are crowding the Army and the Navy. Now, to add to the complexity of the situation and to back up the strength of both private and commercial interests, comes the radiophone and its unprecedented, almost universal use, in America, whereas no other nation is, by comparison, using the radiophone.

Sorely needed now, therefore, is a governmental policy. Sorely needed, accordingly, is a conference among our own governmental agencies, to adjust our National policy to the requirements of the hour. For, clearly, the United States must enter the next conference with a solid front, since, among other complications, not only are the radio facilities that we possess superior to those of any other country, but we are unique in that substantially all our communication services are privately owned.

The immediate results of the Washington Conference are evident enough—the amateur, for instance, got further in it than he himself expected. The commercial companies at least are grateful that the air has been cleared somewhat. The people have had their say and have had an emphatic chance to make their views known.

But the largest results of this conference are inferential after all:

It has hammered home the need of a U. S. radio policy.

It has put Uncle Sam in the way of taking, in radio, the leadership of the world.

ONE COMMERCIAL SIDE OF RADIO

What is the Future of the Radio Business in the United States? Is it to be Like the Telephone, the Automobile, or the Phonograph Business, a Thing that Will Rise Suddenly to Almost Universal Acceptance by the Public and Support Great Manufacturing Plants?

By PARKHURST WHITNEY

A NEW business has suddenly sprung up in the United States—the making of radio receiving sets and the parts thereof. It is of some importance that the public realize what manufacturers are in it and what are the conditions in which they are producing, and it is interesting to speculate upon the possibilities of this, in some ways, new industry.

It is using a method often employed by get-rich-quick concerns to compare a new business with successful old ones, but if the reader bears in mind that these comparisons show the maximum possibilities and not necessarily anything else, it is permissable.

There are ten million automobiles in the United States. It took twenty years to reach this figure, but in that period the making of automobiles has developed into one of the largest manufacturing businesses in the country. The average expenditure for cars and parts is about five billions a year.

There are about six million phonographs in the country. In 1914 the output of machines was 514,000, having a value of $15,291,000; in the same year 27,221,000 records, having a value of $11,111,000, were made. In 1919, the total output of machines was 2,226,000 valued at $91,569,000; the total output of records was 106,997,000, valued at $44,600,000. For purposes of comparison, however, the figures for 1919 in the phonograph industry are not normal. The output for each of the last two years has not approached those figures.

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These are all businesses contributing to the

commercial prosperity of the nation and to the intelligence, well-being, and enjoyment of its inhabitants.

In these matters the radio business might be like unto these others. What are its commercial possibilities? How large is it destined to be? It is theoretically possible for every family and every office to have a radio receiving set. Practically, if the radio receivers are looked upon as necessary conveniences, receivers might become nearly universal. If they are considered valuable chiefly as a means of providing amusement or educational information, they will be much less numerous.

The maximum—taking the automobile standard—would be about ten million. The lower figure—taking the phonograph standard—would be about six million. If the average investment for each receiving set were only $50, the total investment for the lower number would be $300,000,000. If the country should become saturated with these six million receivers in a period of five years, that would mean $60,000,000 of new business for each year.

These are the roughest kind of figures upon a very general hypothesis, but they serve to show the possibilities—perhaps not the probabilities, but the possibilities of this new addition to American industry. These possibilities and probabilities are admittedly guesswork, even by those whose financial interests are the greatest, and the records of the business so far are too meagre to do much except to stir the imagination.

To reach anything like these figures, both present sending and receiving apparatus needs improvement, regulation must be both wise and effective, and a skillful direction of broadcasting must be built up on a solid commercial foundation which does not now exist.

In 1919, the selling of radio telephone receiving sets to the public did not exist as a commercial business. There were more than ten thousand sending and receiving sets for radio telegraph work and there were radio telephone receivers in existence, but not in general public use. Nor was there any demand for them, for no stations were broadcasting entertainment or information to the general public.

It is quite likely that the war affected the radio telephone in two ways—hastened its mechanical development and delayed its commercial development. Experiments carried out in 1915 by the American Telephone and Telegraph Company, and subsequently, when voices at Arlington, Va., were heard in Paris, France, illustrated its possibilities in a striking way. After our entrance in the war our engineers were concerned with the military application of the radio telephone, such as communication between airplanes and the ground, the development of submarine chaser radio telephone sets and miscellaneous sets for field use. These activities resulted naturally in improvements in the apparatus, and likely enough laid some of the ground work for the present interest through the wide contact of men in service with radio telephony. Still, broadcasting to the general public was entirely undeveloped, and that was the situation during two years following the war. The Navy had, of course, used the radio telephone widely during the war, and after the war some messages were broadcasted, but the matter sent out did not start the public buying receivers. In 1915 the American Radio & Research Corporation, of Medford Hillside, Mass, did some broadcasting but not on a regular schedule.

In 1920, however, the Westinghouse Company opened a broadcasting station, at East Pittsburgh, Pa. The programmes of this station and the next one started at Newark were arranged for public consumption and the public was so advised, the station at Newark having the very effective exploitation of the Newark *Call*, the first newspaper to publish the radio section which is now becoming very common.

The East Pittsburgh station was opened November 5, 1920. In the fall of 1920, then, the public first had reason to buy radio telephone receiving sets, and it began to buy. The East Pittsburgh station of the Westinghouse Co. unquestionably began the present sensational developments. The public bought all the equipment that was for sale and from that time to this the manufacturers have never been able to catch up with the demand. The manufacturers of radio receivers and accessories are much in the situation that munition makers were when the war broke. They are suddenly confronted with a tremendous and imperative demand for apparatus. It is a matter of several months at best to arrange for the quantity production of radio receiving apparatus if the type to be manufactured were settled, but the types are no more settled than were the types of airplanes in the war. The

manufacturing companies are, therefore, confronted with carrying on their experimental work, devising new types and at the same time producing the best they can in such quantity as they can, and they must do all this while building up their organizations, working out their policies, and keeping an eye on the activities of the Government so that they can keep in accord with its regulations.

Up to the present, Secretary Hoover estimates that there are 600,000 receiving outfits in the United States, including both those bought complete or nearly so and those constructed by the owners. Even if all the manufacturers' figures were available, it would be difficult to give an exact figure because so many people have bought parts and constructed their own sets. In 1922, there seems indisputable evidence that the sale will equal or exceed 1921. The first quarter of the year has seen an avalanche of ordering. Everything that could be produced has been sold.

The radio manufacturing field differs from the automobile and phonograph industries in their beginnings. The early manufacturers of automobiles and phonographs did not include great establishments already engaged in kindred work, but were chiefly concerns that began in a comparatively small way as automobile makers or phonograph manufacturers.

And the automobile and phonograph businesses grew slowly compared with the radio business. The early automobile and phonograph companies would have been even worse swamped with such a demand as now confronts the radio manufacturers than these concerns are. The reason for this is that in the radio field, besides the manufacturers chiefly engaged on radio apparatus, the big electrical companies, facilities are also available.

Among those companies depending chiefly on the radio business are such manufacturers as the American Radio & Research Corporation, of Medford Hillside, Mass; The Adams-Morgan Co., Upper Montclair, N. J.; Acme Apparatus Co., Cambridge, Mass.; Atlantic Radio Co., Inc., Boston, Mass.; Clapp-Eastman Co., Cambridge, Mass.; F. A. D. Andrea, New York; A. H. Grebe & Co. Inc., New York; Colin B. Kennedy Co., San Francisco, Cal.; Remler Radio Mfg. Co., Chicago, Ill. These concerns manufacture receiving sets. They are concerns chiefly built upon the radio business.

Then there are such concerns as the American Telephone & Telegraph Co., with its subsidiary the Western Electric Co.; the General Electric Co.; the Western Electric Company; and the Westinghouse Company—the great electrical companies of the country. As four of the largest broadcasting stations are now operated by the Westinghouse Company, and as a great many of the patents on radio receiving sets are owned by these big companies, it is well for the radio user to understand their position and influence in the field.

Ever since radio communication appeared upon the horizon, the American Telegraph and Telephone Co. has continuously spent money experimenting in this field. The General Electric Company likewise spent a great deal of money to perfect apparatus which it hoped to sell to the various transoceanic radio companies. It had very valuable patents, especially on sending apparatus, prior to our entry into the war. During the war the Westinghouse Company did a good deal of work for the Signal Corps, and it likewise acquired valuable patents, the Armstrong and heterodyne patents among others. Practically all of this activity was based upon the transoceanic commercial radio business and the marine business. At this time the Marconi Company was the chief international radio company. In 1919 the General Electric Co. was about to sell its great Alexanderson transmitters to the Marconi Co. when Admiral W. H. G. Bullard and Commander Hooper, U. S. N. suddenly projected themselves into the situation. The Admiral made a vigorous plea to Mr. Owen Young of the General Electric not to sell to the Marconi Company, for both the British and the American Marconi companies were British controlled. The Admiral argued hard for American control. Mr. Young pointed out that the General Electric Company had no market for these machines but the Marconi Co. That did not disturb the Admiral. His answer was to suggest an American company with Government backing, and he tried to get the Government to back a company to keep the American flag in the ether. In this he failed, but he did finally persuade the General Electric Company to see if an American company could not be started without Government help, to keep the United States from having all its overseas radio in foreign hands. How this was finally worked out is another story—and a very dramatic one to be told later. The result was the formation of the Radio

Corporation of America. The Radio Corporation bought out the American Marconi Co. It has now under the American flag the biggest commercial radio business in the world. It is controlled by the General Electric Co. and the American Telephone & Telegraph Co. In its formation these companies granted to the Radio Company the right to sell the radio products of the General Electric Co. and the Western Electric Co. which are the manufacturing subsidiaries of the Telephone Company. They also agreed that the Radio Company was to hold the radio patents of both concerns and that both were free to use any of the patents in manufacture. After this was done, the Westinghouse Co., rather than deal with foreign radio competitors or set up a rival concern, likewise pooled its patents and agreed to sell through the Radio Corporation. In this way the maximum American strength was combined to meet foreign competition in the commercial radio field.

Then, suddenly, broadcasting aroused the demand for receiving sets. The Radio Corporation formed for entirely different purposes found itself besieged with a demand. It has put forward its utmost energy to get equipment from all its manufacturing connections and the fact that the patents of the American Telephone & Telegraph Co., the Western Electric Co., the General Electric Co., and the Westinghouse were all pooled has greatly facilitated the supplying of the public demand.

The results of the pooling of the patents of the big electrical companies makes it seem possible that it might be in the public interest if similar coöperation included the whole field and that the patent situation in radio were worked out by coöperation rather than litigation. This would in no wise impair competition in manufacture. There is now keen competition between the manufacturing concerns who sell through the Radio Corporation as well as between the Radio Corporation and all other manufacturers. The position of the American Telephone & Telegraph Company is a little different from that of any of the manufacturing companies. It makes no instruments. It is not interested in broadcasting as a means of selling instruments. Its business is selling communication. If a man wants to talk from the mainland of California to Catalina Island, the telephone company will give him this service by radio. A similar service is being considered across Albemarle Sound, N. C.

Similarly if a man would like to talk to all his neighbors at once and can pay for it, the American Telephone & Telegraph Company will try to equip itself to provide him the service by radio. The company is completing a broadcasting station for the purpose in New York. But it is frankly an experiment. The demands of the public will determine radio's future in this as in all other respects.

The most obvious motive for wishing to talk to all one's neighbors is for the purpose of selling them something. The Conference under Secretary Hoover's chairmanship agreed that it was against public interest to broadcast pure advertising matter. The American Telephone & Telegraph officials agreed with this point of view. Their experiment is to see whether there are people who desire to buy the right to talk to the public and at the same time tell the public something it will like to hear.

If this experiment succeeds, a commercial basis for broadcasting will have been established. If it does not succeed the public will be left with the free broadcasting of the companies that sell equipment, the newspapers, etc. If the selling of equipment keeps on as at present, the companies that sell largely can perhaps continue to bear the expense of broadcasting. But as the present rate of buying shades down and competition becomes keener and closer, it might not be possible for one company or group to bear the expense of broadcasting which is the stimulant for the demand that all manufacturers enjoy.

These problems affect not only the Westinghouse Co., which operates four stations, but the operators of many other broadcasting stations as well. Altogether, according to present available information, there are more than twenty stations which broadcast extensively. The General Electric Company broadcasts at Schenectady; the American Radio and Research Corporation broadcasts from Medford Hillside near Boston; the C. D. Tuska Co. from Hartford, Conn.; the Carter Electric Co. from Atlanta, Ga.; the Precision Equipment Company from Cincinnati, Ohio; the Western Radio Company from Kansas City, Mo.; the Reynolds Radio Co. from Denver, Col. The state universities at Madison, Wis., Austin, Texas, and at Lincoln, Neb., also broadcast, and on the Pacific Coast a number of commercial houses pay the costs of a broadcasting station for the advertising they receive, although the advertising consists of little more than the mention of

their names. In Seattle, Wash., a newspaper, the *Post-Intelligencer*, also maintains a service, as does the Detroit, Mich., *News*. There are short range stations in many other cities and no doubt the number is constantly increasing.

All these stations give entertainment to which the public listens free of charge. The artists give the entertainment and the concerns that pay for the broadcasting get some incidental advertising. All manufacturers naturally share in the benefits of the sales which such broadcasting stimulates.

Although the Radio Corporation group is made up of the largest electrical companies, it has nothing like a control in the supply of radio equipment. The loud speaker is manufactured under various trade names by such concerns as the Magnavox Co., of San Francisco; John Firth & Co., and the American Pattern, Foundry and Machine Co., of New York; Riley-Klotz Mfg. Co., Newark, N. J. Head sets are produced by such concerns as C. Brandes, Inc., New York; Nathaniel Baldwin, Salt Lake City, Utah; William J. Murdock Co., Boston; Stromberg-Carlson, Rochester, N. Y. The Atlantic-Pacific Radio Supplies Co., of San Francisco, is widely known as a maker of tubes.

Under these conditions what is to be the future of radio as a business? Is it to reach its maximum and become a convenient necessity, a common object in nearly every household; or is it to be far less prevalent? The answer lies fundamentally in the character of service performed by the broadcasting stations, and in the refinement of the receiving instruments. Technically neither the sending machinery nor the receiving machinery is as good as it should and will be, and the science of preparing broadcasting programmes is in its infancy.

The basis on which broadcasting will ultimately be paid for is undetermined, and it is not even clear yet who will eventually do the broadcasting, or what will be broadcasted. After the novelty of listening to words and music in the air wears off, the public will listen not for the sake of listening but for what it hears. If what it hears is of compelling interest or importance, the public will listen. If not it will do something else. If listening is to become a national custom, broadcasting must become a high art and some permanent and ample means provided to support this art.

WHAT TO EXPECT FROM YOUR RECEIVER

By ARTHUR H. LYNCH

RADIO has been surrounded by so much mystery for the last few years that the present stimulation has naturally brought with it a great deal of misinformation. This misinformation has led many people to expect results from their receiving sets which they ought not to expect. There is an unfortunate lack of accurate information covering the range in miles over which various types of receiving sets will function satisfactorily.

Now and again, we find an item in the daily press describing some new form of receiving set made to fit in a match box, a watch case or a thimble, with which it is but necessary to place one's foot against a hydrant and hold an umbrella over one's head to hear signals from infinitely great distances. We hear also of loop aerials being used to pick up radio concerts from stations hundreds of miles distant.

Unquestionably there are very small receiving sets which actually do operate. There are also certain stations where reception over great distances is possible with a loop aerial. However, the belief that the two may be combined is very far from being correct.

The small set may be operated over comparatively short distances from a broadcasting station, and it is safe to say that the average maximum distance for such reception is 15 miles. Where the loop aerial is used for receiving over long distances, it is necessary to employ accurately designed vacuum tube apparatus which cannot be made to operate satisfactorily by an inexperienced person.

Another common error concerning radio

receiving outfits is the impression that a "loud speaker" attached to a simple crystal receiving set will provide sound great enough to fill an entire room. Except at very short ranges this is not true. Radio "loud speakers" operate on precisely the same principle as the phonograph. A great vibration of the diaphragm produces a great sound and a comparatively smaller vibration of the diaphragm results in the correspondingly decreased sound volume. With phonographs this is brought about by the use of loud and soft tone needles, although the same record may be employed. With radio, the volume of sound produced by a loud speaking device depends upon the energy received from the transmitting station. With a simple crystal receiving set "loud speakers" cannot be employed directly, unless the receiver is located very close to the transmitting station. Where a vacuum tube detector is employed, the distance from the receiving station may be increased somewhat, but even this method is not recommended for general use.

Regardless of what type receiver is employed, where the distance from a broadcasting station is more than a few miles, it is necessary to use an amplifier where a "loud speaker" is desired.

An amplifier is a combination of units, which, working together, build up signal energy from the original energy absorbed from the air by the receiving aerial system. In general, amplifiers comprise one or two vacuum tubes with the necessary connecting equipment and controls, operated by a 6 volt, 40 to 100 ampere hour storage battery and two or three 22.5 volt "B" or plate batteries. Where two tubes are used, the amplifier is called a double stage amplifier, and means is generally provided for making instantaneous connection to the first or second stage at will, thus regulating the volume of the signal produced.

The action of this character of amplifier is quite simple. The incoming radio signal is passed through the tuning elements of the receiver to the detector tube or crystal as the case may be and from here it is carried into the first amplifier tube. This amplifier tube functions as a valve and this valve is controlled by the intensity of the incoming waves. When the energy of the incoming wave is great, the valvular action of the tube is great; when the incoming energy is small, the reverse is true. This valvular action draws a current from the plate battery which is passed through the telephone receivers or "loud speaker" as the case may be.

For every variation in the antenna current there is a very considerably augmented variation in the plate battery current, so that the resultant signal is very greatly increased. Where two stages of amplification are employed, the signals from the first stage are used to control the valvular action of the second amplifier tube and the resultant energy is carried from that plate circuit to the telephones or "loud speaker." With each stage of amplification of the signal, audibility is increased from six to ten times.

More than two stages of this character of amplification are not recommended for ordinary use because there is a tendency to amplify disturbances from the atmosphere as well as disturbances from local trolley, power, and telephone lines, causing the production of parasitic noises which interfere with the reception of speech or music.

Although the range in miles over which the various classes of receiving outfits may be counted upon to function satisfactorily cannot be judged closely, the following table may be found of value, and where a dealer recommends the use of apparatus listed therein for the accomplishment of greater work, the consumer should investigate very thoroughly before concluding that the information is correct. There are exceptional cases, when the ranges will be found to be greatly extended, but they cannot be considered as standard. For instance, the range for any receiver is much shorter during the day than it is at night, and it is a common thing for stations having a normal range of 15 or 20 miles to receive from distances up to 50 or 60 miles.—

1. Simple crystal receivers with outdoor aerial 15 miles, with indoor aerials 3 to 5 miles, with loop aerial 1 to 3 miles, with outdoor aerial and "loud speaker" about 2 miles.

2. Vacuum tube receiver operated by dry cell with outdoor aerial—75 miles, with indoor aerial 30 miles, with loop aerial 5 to 10 miles, with a "loud speaker" and outdoor aerial 5 miles.

3. Vacuum tube receiver with two stage amplifier and "loud speaker" 75 miles, with telephones 150 miles. Loop aerials are not recommended for use except by persons having a thorough knowledge of their capabilities and limitations.

A method has been devised for increasing

the distances over which receiving outfits will function satisfactorily. This method employs what is known as radio-frequency amplification. The beginner should not attempt the use of this method unless he purchases radio-frequency amplifying units complete, because some difficulty may be experienced in assembling the various parts, which go to make an amplifier of this kind.

Where we hear of signals being received over very long distances by stations employing a loop aerial, it is safe to conclude that radio-frequency amplification is being used. With a loop three feet square, wound with five or six turns of lamp cord functioning with suitable radio-frequency amplifiers, very great distances may be covered. The loop form of reception is very valuable for the reduction of static and interference because it is only influenced by signals from points directly in line with the winding of the loop. That is, in order to receive from any station the loop must be pointed toward that station and interference having its origin in any other direction does not occur. Therefore, the only interference likely to occur is caused by two or more stations operating on the same electrical wave length and located in the same direction from the receiving station. With two stages of radio-frequency, signals have about the same intensity as exists when the average amateur outdoor antenna is used in connection with a standard regenerator circuit employing one vacuum tube.

RADIO PERSONALITIES

I.

PAUL GODLEY

By A. HENRY

IT IS doubtful whether any one human being in radio circles holds the interest of Americans more completely than Paul Godley. Much of this interest is the direct result of the transatlantic amateur transmitting tests completed a short time ago, in which Mr. Godley played the leading rôle, but he has also taken part in other remarkable radio activities.

Before considering these recent events it is interesting to ponder for a moment or two upon the work this man has done for radio in the past.

Paul Forman Godley was born September 25, 1889, at Garden City, Kansas. His interest in radio began about the time he entered Defiance College in Ohio. His studies there lasted for five years. During his summer vacations, Mr. Godley devoted himself to telegraph work with commercial companies and railroads in various capacities, from operator to train dispatcher.

Being interested in communication, it was quite natural for him to become enthusiastic about radio and he studied all the available literature on radio communication published at that time. In 1908 a commercial wireless station was built in Chicago, to which Mr. Godley was assigned by the operating company. Once in a position actually to handle commercial radio equipment, Mr. Godley made every effort to become proficient in its installation and maintenance, as well as its actual operation.

The United Wireless Telegraph Company opened a commercial station at Grand Rapids, Michigan, in the summer of 1909 and Mr. Godley was put in charge.

Later in the same year, an agreement was made with Dodges Institute of Telegraphy, Valparaiso, Indiana, to inaugurate a course in wireless telegraphy over which Mr. Godley had jurisdiction.

In 1911, Mr. Godley was placed in charge of a course in wireless telegraphy at the Collegiate Institute, Port Arthur, Texas, and in 1912 he took up the duties of Wire Chief for the Postal Telegraph Company at their main New York office.

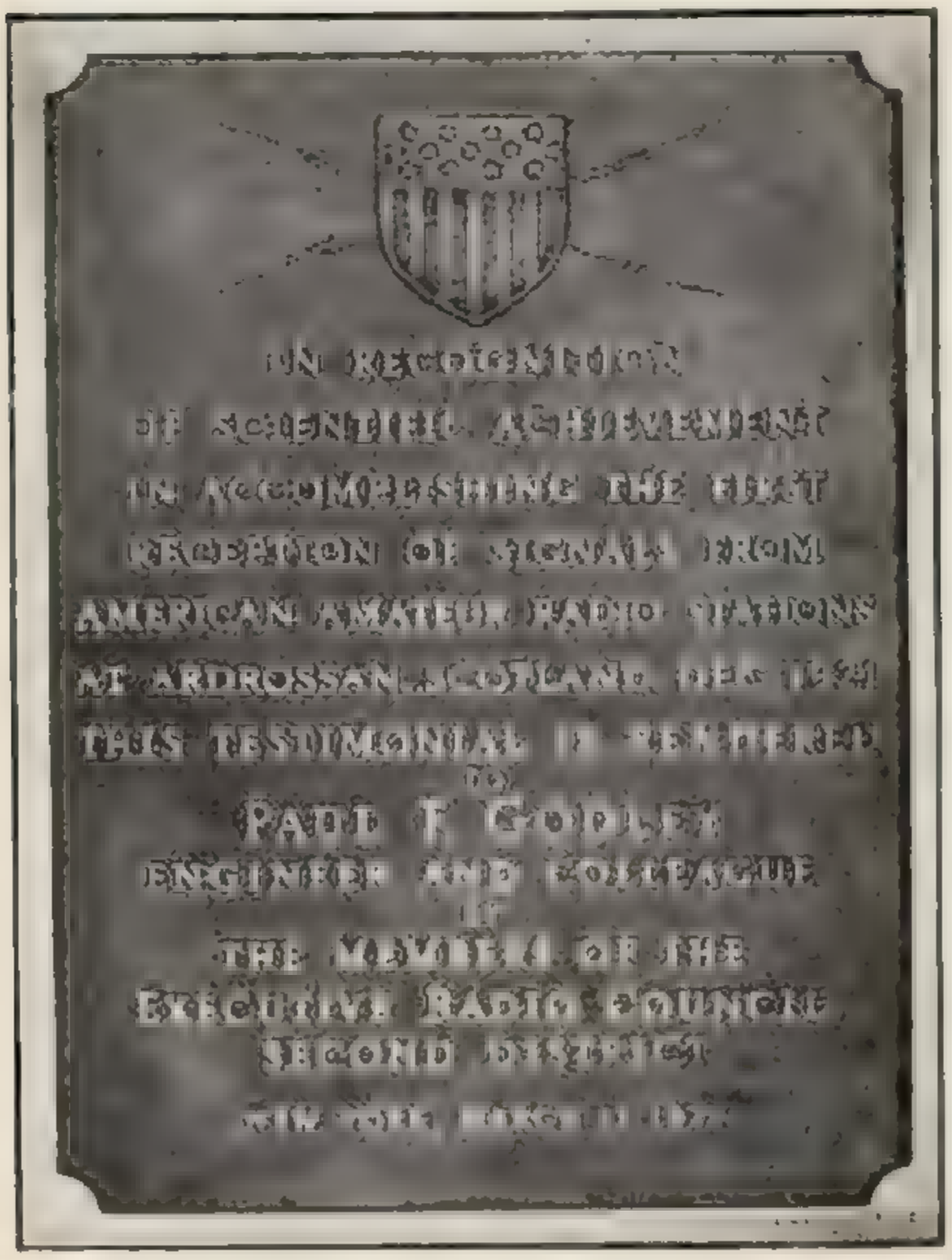
The year 1913 found Mr. Godley on the "Amazon-to-the-Andes" radio service for the Brazilian Government, during which time his experiences were as varied as they were instructive. In 1914 Mr. Godley returned to the United States, and began a study of research at his home, Leonia, New Jersey, where he devel-

oped the short wave regenerative receiver now so familiar to American radio enthusiasts.

After a winter of experimentation with receiving outfits, Mr. Godley opened a transmitting station (2 ZE) and many exceptional distance records were made during the time this station was in operation. More than anything else this station became widely known in amateur radio circles for its consistency in daylight work. Communication between Albany, Baltimore, and Philadelphia via Leonia was a regular occurrence.

In 1915 and '16 Mr. Godley was called upon by numerous radio clubs and engineering societies to discuss radio problems, and one of the first appreciations of the great possibilities of the vacuum tube and its application to amateur radio was contained in his paper "Applications of the Audion," read before the Radio Club of America in New York City. Most authorities on radio credit Mr. Godley with having taken the Armstrong Regenerative Circuit, for a time considered impracticable for short wave work, and arranged it to function satisfactorily for the amateur.

Toward the end of 1915, Mr. Godley became a member of the Adams-Morgan Company, Upper Montclair, New Jersey, and he is largely responsible for the production of "Paragon Radio Apparatus."



During the war, Mr. Godley served as Designing Engineer at the Marconi Wireless Telegraph Company of America's factory, Aldeen, New Jersey, having charge of receiver design, and the apparatus developed by him during this period for army and navy use has been commented upon very favorably. One particular type of receiving equipment, developed for Signal Corps use, was the only American built apparatus mentioned in the report of the Chief Signal Officer to the Secretary of War.

TRANS-OCEANIC RADIO TESTS

SO MUCH has been said regarding the successful attempt of American amateurs to record their signals in Europe that it is not necessary to go into detail. In brief, Mr. Godley was chosen by the American Radio Relay League to undertake this very important mission and equipped with what he considered suitable receiving apparatus, he left this country and put up a temporary receiving station in Scotland.

Mr. Godley's first attempts to hear American signals were greeted by the English press as more or less problematical and one particular London paper went so far as to ridicule his effort. However, twenty-six American amateur stations were heard during the time Mr. Godley stayed in Scotland; his operations were checked by representatives of radio amateurs in Great Britain as well as executives of large radio companies there.

THE WASHINGTON CONFERENCE

WITH the very marked stimulation in radio communication brought about, no doubt, by the recent development of radio broadcasting, our Government appreciates the fact that existing radio communication laws are not adequate to cope with existing conditions. For this reason, Secretary Hoover called upon a number of radio men to convene in Washington and made suggestions regarding new laws with special attention to the amateur and the radio enthusiasts. When asked for his opinion regarding the conference and its likely outcome, Mr. Godley replied:—

"Brought about by the rapid growth of radio broadcasting, I feel that the conference recently held in Washington developed as fine a working basis as could have been wished by any interest in a very short time. Particu-

larly fortunate were we in having a man of such calibre as Herbert C. Hoover, to steer the course of the commission. On the first day of the conference it had been generally agreed by all concerned that, firstly, for the proper continued growth of the art and industry proper, governmental control was absolutely essential: Secondly—that the order of importance of the various classes of service was (*a*) insurance of safety of life at sea; (*b*) radio broadcasting of desirable information and entertainment; (*c*) a continuance of amateur activities to the fullest possible extent within certain suitable fixed bands and point to point broadcasting to provide communications over stretches where existing systems are impossible."

A very significant fact brought out at the conference was that material changes in wave lengths are likely to be put in effect in order to eliminate some of the broadcasting problems which now exist. This legislation is highly desirable for at least two very good reasons. Firstly, broadcasting programmes are at present seriously interfered with by "ship to shore" commercial telegraph work even at points remote from the seacoast during certain seasons of the year and with the least selective types of receivers. These programmes are also interfered with to some extent by indiscriminate and improperly regulated amateur transmission. Secondly, broadcasting stations on the shorter wave lengths designed to cover a radius of 150 miles very frequently cover a radius of 1,500 miles and occasionally their range is even greater than that.

This phenomenon which occurs at night during the winter, is known as "fading," and frequently results in interference and confusion.

It is quite noticeable that fading is comparatively absent on wave lengths of the order of 1,000 or 1,500 meters.

The use of short wave lengths, then, greatly diminishes this reliability of the broadcasting schedules and if broadcasting is to enjoy the very remarkable future which opens up before it, it must be stabilized in every possible manner.

To make broadcasting other than a temporary fad, it must be made dependable and upon its dependability and permanence in the American home rests the future prosperity of those industries built upon it which are now growing so rapidly.

PAUL GODLEY

RADIO BROADCASTING HERE TO STAY

REGARDING this very important phase of radio Mr. Godley made the following statement. "There is little doubt in my mind that radio broadcasting is here to stay, and that before many years it will be utilized in as many as five million American homes, for it may very well come to play a part in our lives equalled only by that of the daily, weekly, and monthly periodical. Like the moving picture industry, it will need to grow from a crude infancy into something greater and grander than is at present possible—its applications may even surpass in their scope the wonders of the motion picture as we know it to-day.

"But this development is very apt to be much more rapid, for, in a great sense, each broadcast

listener will be his own operator, critic, director, and even producer. There will be a great variety to select from, and each of the purveyors of this service will be on the continual lookout for suggestions and criticism.

"Radio broadcasting can never quite become a case of 'see our picture or stay at home' and, besides, the Department of Commerce promises to follow radio broadcasting very closely in order to make certain that proper and popular programmes are provided. This is as it should be. One might even allow himself to imagine that some time in the future the popularity of a political party in office may hinge entirely upon the quality of broadcasting service."

II

DR. ALFRED N. GOLDSMITH ON THE FUTURE OF RADIO TELEPHONY

By EDGAR H. FELIX, A. I. R. E.

WHEN Dr. Alfred Norton Goldsmith speaks of the future of radiocommunication, he speaks with authority. Since 1912 he has been editor of the *Proceedings* of the Institute of Radio Engineers and has for the last five years been the institute's secretary. This body includes in its membership the two thousand leading radio experts, engineers, and executives scattered in all parts of the world. Its *Proceedings* is the recognized technical authority on radio.

But Dr. Goldsmith's position of authority is based upon more than this. He is Director of Research of the Radio Corporation of America, the dominating organization of the radio industry. In this important work he is in closer touch with progress and development of radio communication than any other man in American radio.

For many years, Dr. Goldsmith has directed the radio laboratories of the College of the City of New York. His interest in radio was born here when but a few advanced scientists had recognized the possibilities of the Hertzian experiments as a means of communication.

Professor R. Ogden Doremus, one of the College's leading scientists, was responsible for bringing to the United States several important scientific discoveries. Although the early experiments of Hertz, which laid the foundation of radio communication, did not attract much attention even in the scientific world, Professor Doremus was one of the few who recognized their importance. He therefore, with painstaking accuracy, had exact replicas of Hertz's apparatus made by one of Hertz's coworkers and they are now a part of the equipment of the College of the City of New York.

Unlike his fellow students, Dr. Goldsmith did not content himself with the brief reference to these experiments which were made at one of the physics classes. He obtained permission to set up the Hertzian apparatus and repeated with the fidelity of a real seeker after the truth the experiments which Hertz reported to the world.

It was in this fashion that Dr. Goldsmith's interest in radio was born. And it is in this fashion, also, that he has kept himself before the radio world as its best informed authority. For instance, when Poulsen announced his first success with the arc for communicating speech, Dr. Goldsmith set up one of the first, if not the first, arc radio telephones in the United States. In this same way, each step in advance has been incorporated in Dr. Goldsmith's wide knowledge by actual experiment, sometimes even before its significance was appreciated by the discoverer himself. It was at City College that Dr. Goldsmith allowed me to hear the signals from the high power station at Honolulu shortly after Armstrong had made his discovery of the feed-back circuit which is now so widely used for reception and transmission.

Dr. Goldsmith has seen radio grow from modest beginnings to a day when its spread resembles that of a hysteria. But, unlike some of his contemporaries, it has not distorted his vision of the future.

"The first thing I wish to make clear is that I do not expect the radio telephone to replace

DR. ALFRED N. GOLDSMITH

the wire telephone. The radio telephone has its own special fields of utility which will require the full use of all the wave lengths available in the ether for radio telephony. It is conceivable that great progress will be made in tuning apparatus which will allow a greatly increased number of radio telephone transmitters to operate at the same time without interference. But the special fields to which radio telephony is particularly adapted precludes its extended use as a competitor of the wire telephone.

"The radio telephone is a new device with a new sphere of utility heretofore filled by no other agency. In general, there are three classes of communication in which the radio telephone will be supreme: communication where natural barriers, such as deserts, mountains or tropical forests, or great spans of ocean make wire telephony an impossibility; second, where the barrier of motion, as in the case of aircraft, automobiles, moving trains, and ships at sea, does not permit the use of wire telephony; and third, for broadcasting purposes, where audiences of tens of thousands, hundreds of thousands, and even millions are scattered over large areas."

Speaking of the first field, Dr. Goldsmith stated that the radio telephone will be an important factor in preserving the unity of nations and empires and strengthening the bonds between men and their governments. Rome fell when her outposts were isolated by slow communication. Rome thrived when she could send her centurions over her marvellous system of roads to any outpost where danger threatened before her enemies could assemble in force. Roman roads permitted rapid communication, with the result that the Romans were invariably ready. But the laxity of Roman officialdom, which accompanied her social and political decay, led to the neglect of the system of highways. When the advantage of rapid communication was in this way lost to Rome, barbarians overran the Empire.

When Rome fell, ours was a thirty day world. The cable and the radio telegraph has reduced its dimensions to a few hours. The radio telephone will make it a one seventh of a second world.

That coördination and unity of nations is fostered by effective communication is well recognized by our own government. Our Navy Department has established a chain of radio telegraph stations linking America's outposts with the central government. The British Imperial communication chain similarly unites that empire by a series of radio telegraph stations.

But radio telephony will bring these bonds still closer. National stability and understanding will be enhanced through the simple means of rapid spoken communication.

International relations will be improved if only by the courteous diplomatic amenities which the radio telephone makes possible. Direct negotiation by radio telephony is unlikely because of its present lack of secrecy. Yet better understanding is bound to result when diplomats of all nations are within elbow reach of each other; when they need but to lift the telephone to speak to each other, no matter how far separated.

The relation of world markets will be significantly modified by the radio telephone. The rapid and accurate transfer of trade information from every corner of the globe to every other corner of the globe will bring a new phase of economic relations in which the needs of the world will be quickly met and the danger of oversupply at one point while shortage exists at another will be eliminated.

The pioneer who opens new lands and new resources to the civilized world will find the radio telephone of constant service. No longer will he be handicapped by continued isolation. The radio telephone will keep him in constant touch with the world he has left behind him, whether his exploration be polar or tropical, or through desert or mountain range. The inestimable resources of Africa and South America will be made available to the world half a century sooner because of the influence of the radio telephone.

The second phase of utility of the radio telephone to which Dr. Goldsmith referred is its successful surmounting of the barrier of motion. He considers as most important in this class radio telephony with aircraft in flight. The pilot of the airplane concentrates his attention on the delicate manipulation of controls. In time of danger, he cannot successfully interpret the slow communication of the radio telegraph by means of the Morse Code. In addition, the radio telephone is a quicker means of communication. It can handle five times as many words in a minute as the manually operated radio telegraph.

Man is trained by centuries of speech communication to grasp instinctively the spoken word, in spite of noise, distraction, and presence of imminent danger. The pilot of aircraft will have no difficulty in acting upon meteorological information and facts about the condition of landing fields as he speeds through the clouds when such information is whispered into his ear through the radio telephone receivers.

Communication from moving trains will probably be handled by means of inductive telephony or wired wireless. The use of the radio telephone for the purpose is unnecessary, and the ether is already overburdened with essential functions. But every train will some day be equipped with receiving sets so that broadcast features will be available to relieve the monotony of travel.

The field of radio telephone communication with moving automobiles is limited, but is nevertheless of some importance. The control of police forces, of emergency gas and electric service units from their respective central headquarters will greatly aid in coping with crime and emergency.

The days, weeks, and even months of separation which a sea journey involves are often of consequence, and it is likely that considerable traffic will be handled between persons at sea and business associates and friends ashore. At present radio telephony is not permitted on commercial ship radio telegraph wave lengths, but it is likely that the radio telephone distress signal will replace the code S. O. S. Not only is speech communication so much more rapid—a factor often of vital importance in case of distress—but the vividness and accuracy of a voice appeal through the ether far surpasses that of the code message.

But when we discuss broadcasting and its possible uses and results, we may well hesitate. Even the most extravagant predictions cannot touch the real possibilities. Dr. Goldsmith suggests an interesting possibility:

"At last we shall have a 'voice of the government.' The Government will be a living thing to its citizens instead of an abstract and unseen force. The National Government will speak to every citizen by means of nationally broadcasted proclamations and statements of policy. A new understanding of national problems and national coöperation must necessarily arise.

"The broadcasting of information from our various government departments will not only serve to increase their respective efficiency and their service to the people but will build up in the consciousness of our citizenry a new knowledge of what our government is and what it does. It will elicit a new national

loyalty and produce a more contented citizenry.

"It is proposed that the debates of our Senate and House of Representatives, of state legislatures, and even of municipal governing bodies shall be broadcasted. At last we may have covenants literally openly arrived at, and a new era in politics. Elected representatives will not be able to evade their responsibility to those who put them in office.

"Inventions of the last century have served to make man's life more complex. Although many physical burdens and inconveniences have been removed, every development, except the motion picture and the phonograph, have drawn more and more upon man's nervous energy by increasing the speed at which business is done and the pace of life in general. The radio telephone, however, will bring a new joy into man's life. It will disseminate culture not to thousands but to hundreds of thousands and to millions.

"A man need merely light the filaments of his receiving set and the world's greatest artists will perform for him. Whatever he most desires—whether it be opera, concert, or song, sporting news or jazz, the radio telephone will supply it. And with it, he will be lifted to greater appreciation. We can be certain that a new national cultural appreciation will result.

"Undoubtedly there will be other features of broadcasting which have not made their appearance. The people's University of the Air will have a greater student body than all of our universities put together. The educational application of radio is an immense field so far untouched.

"But," continued Dr. Goldsmith, "let us content ourselves with this picture. The future of radio telephony and the results it will accomplish is a story which would have staggered the intellect of Jules Verne. What I have given you are merely a few suggestions, the realization of which is only a matter of time. The deliberations of the Radio Telephone Commission at Washington, from which I have just returned, has considered each of the uses of radio telephony because definite plans are already under way to carry out many of these services."

This is an adequate answer to those who consider broadcasting a temporary fad. Let us join the march of progress in which such able men as Dr. Alfred Goldsmith are leading.

HOW TO BUILD AND OPERATE A VERY SIMPLE RADIO RECEIVING SET

This article is Letter Circular L C 43 of the Bureau of Standards, Department of Commerce. The edition of the circular is small and the editors of Radio Broadcast feel it a public service to bring this most authoritative matter within the reach of all beginners.

THIS article describes the construction and operation of a very simple and cheap radio receiving outfit which will enable one to listen both to radio code messages and to music and voice transmitted by radio.

This article shows how to construct the entire receiving station, including antenna as well as a crystal-detector receiving set. This station will enable one to hear the messages sent from medium-power transmitting stations within an area about the size of a large city, and to hear high-power stations within 50 miles, provided the waves used by those stations have wave frequencies between 500 and 1500 kilocycles per second (i. e., wave lengths between 600 and 200 meters). Much greater distances are often covered, especially at night. If a person constructs the coil and other parts as indicated, the total cost of this set can be kept down to about $6.00. If, however, a specially efficient outfit is desired, the cost may be about $15.00.

ESSENTIAL PARTS OF RECEIVING STATION

THERE are five essential parts: the antenna, lightning switch, ground connections, receiving set, and phone. The received signals come into the receiving set through the antenna and ground connection. In the receiving set they are converted into an electric current which produces the sound in the

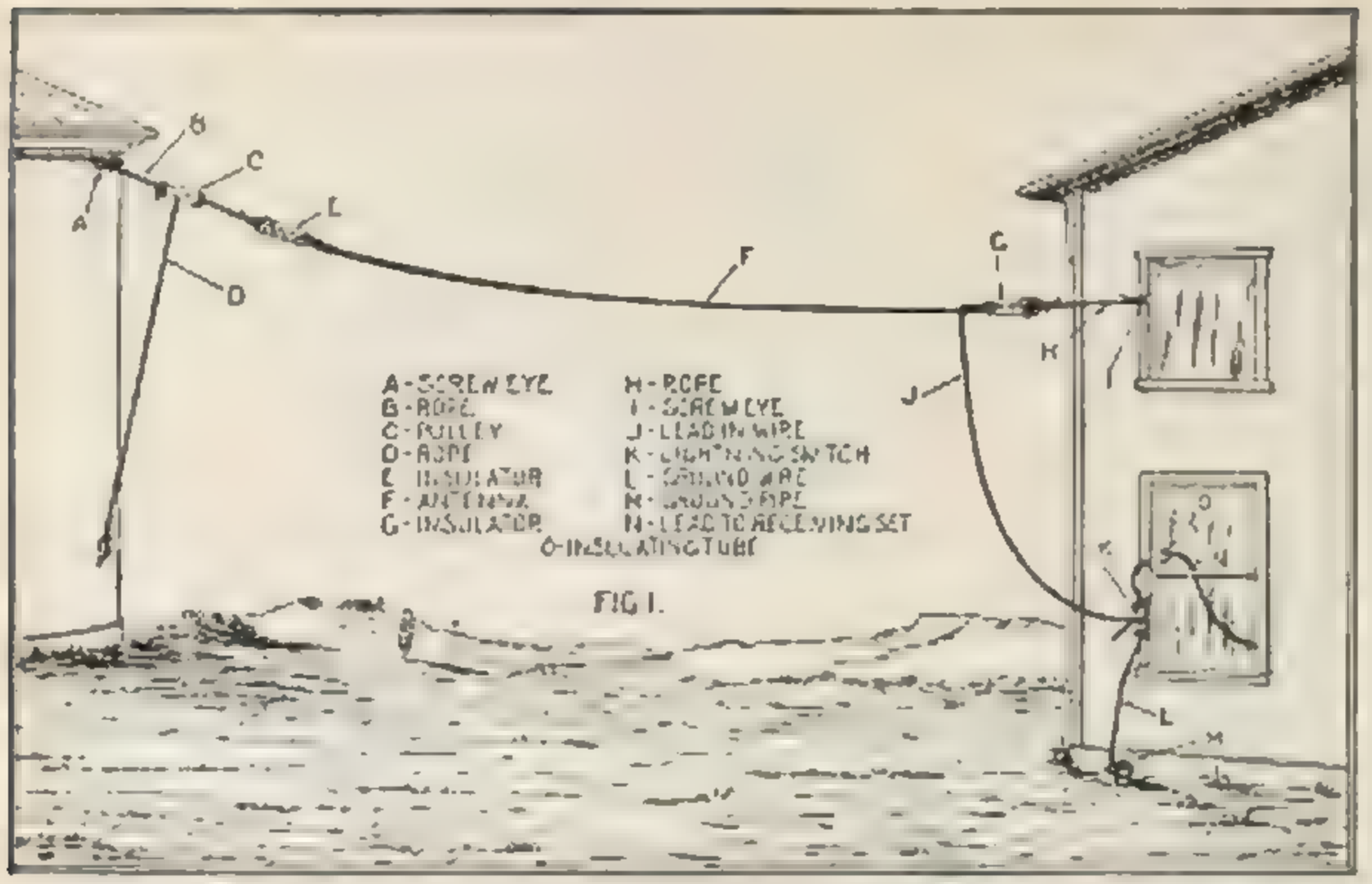


FIG 1.

Figure 1 Showing the exterior equipment for the radio telephone receiving set. The antenna does not have to be horizontal

"phone." The phone is either one or a pair of telephone receivers worn on the head of the listener.

The purpose of the lightning switch is to protect the receiving set from damage by lightning. It is used to connect the antenna directly to ground when the receiving station is not being used. When the antenna and the connection to the ground are properly made and the lightning switch is closed, an antenna acts as a lightning rod and is a protection rather than a source of danger to the building.

The principal part of the station is the "receiving set." In the set described herein it is subdivided into two parts, the "tuner" and the "detector," and in more complicated sets still other elements are added.

THE ANTENNA, LIGHTNING SWITCH, AND GROUND CONNECTIONS

THE antenna is simply a wire suspended between two elevated points. Wherever there are two buildings, or a house and a tree, or two trees with one of them very close to the house, it relieves one of the need of erecting one or both antenna supports. The antenna should not be less than 30 feet above the ground and its length should be about 75 feet. (See Fig. 1.) While this figure indicates a horizontal antenna, it is not important that it be strictly horizontal. It is in fact desirable to have the far end as high as possible. The "lead-in" wire or drop-wire from the antenna itself should run as directly as possible to the lightning switch. If the position of the adjoining buildings or trees is such that the distance between them is greater than about 85 feet, the antenna can still be held to a 75-foot distance between the insulators by increasing the length of the piece of rope (D) to which the far end of the antenna is attached. The rope (H) tying the antenna insulator to the house should not be lengthened to overcome this difficulty, because by so doing the antenna "lead-in" or drop-wire (J) would be lengthened.

Details of Parts.—The parts will be mentioned here by reference to the letters appearing in Figures 1 and 2.

A and I are screw eyes sufficiently strong to anchor the antenna at the ends.

B and H are pieces of rope $\frac{3}{8}$ or $\frac{1}{2}$ inch in diameter, just long enough to allow the antenna to swing clear of the two supports.

D is a piece of $\frac{3}{8}$- or $\frac{1}{2}$-inch rope sufficiently long to make the distance

Figure 2. Showing interior arrangement of equipment

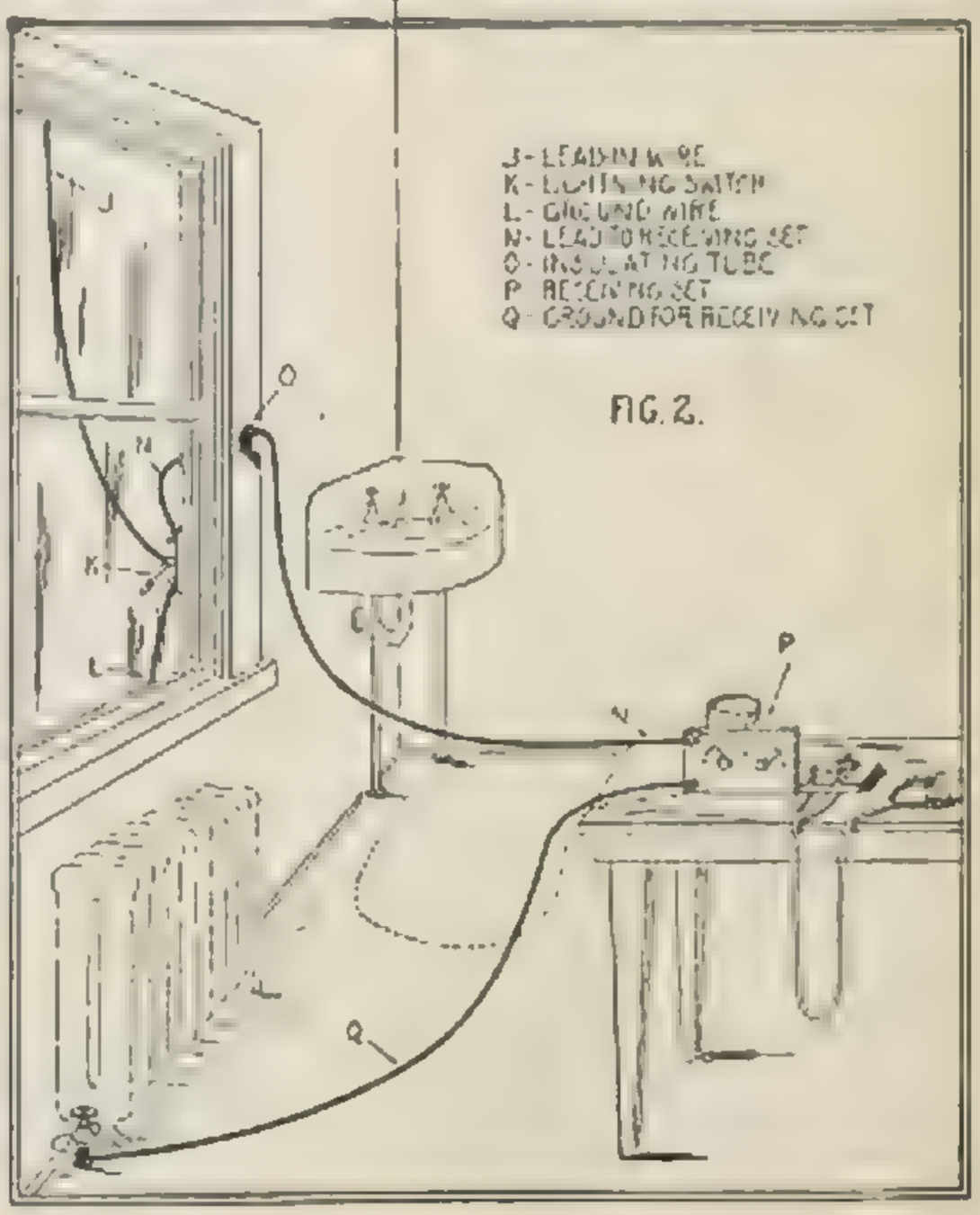


FIG. 2.

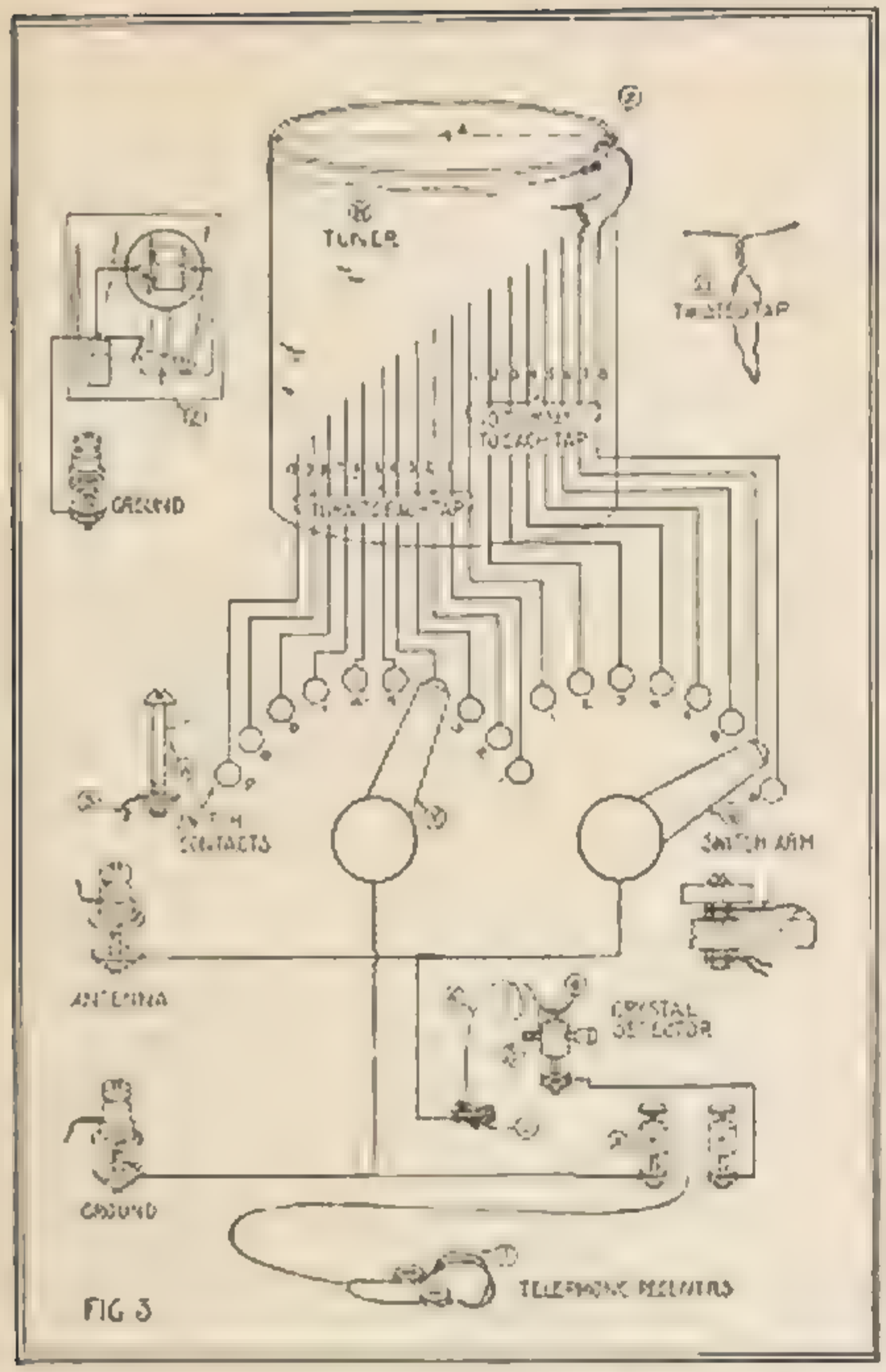


Figure 3. The tuner and certain accessories can be made at home

between E and G about 75 feet.

G is a single-block pulley which may be used if readily available.

E and G are two insulators which may be constructed of any dry hard wood of sufficient strength to withstand the strain of the antenna; blocks about 1½ x 2 x 10 inches will serve. The holes should be drilled as shown in Fig. 1 sufficiently far from the ends to give proper strength. If wood is used the insulators should be boiled in paraffin for about an hour. If porcelain wiring cleats are available they may be substituted instead of the wood insulators. If any unglazed porcelain is used as insulators, it should be boiled in paraffin the same as the wood. Regular antenna insulators are advertised on the market, but the two improvised types just mentioned will be satisfactory for an amateur receiving antenna.

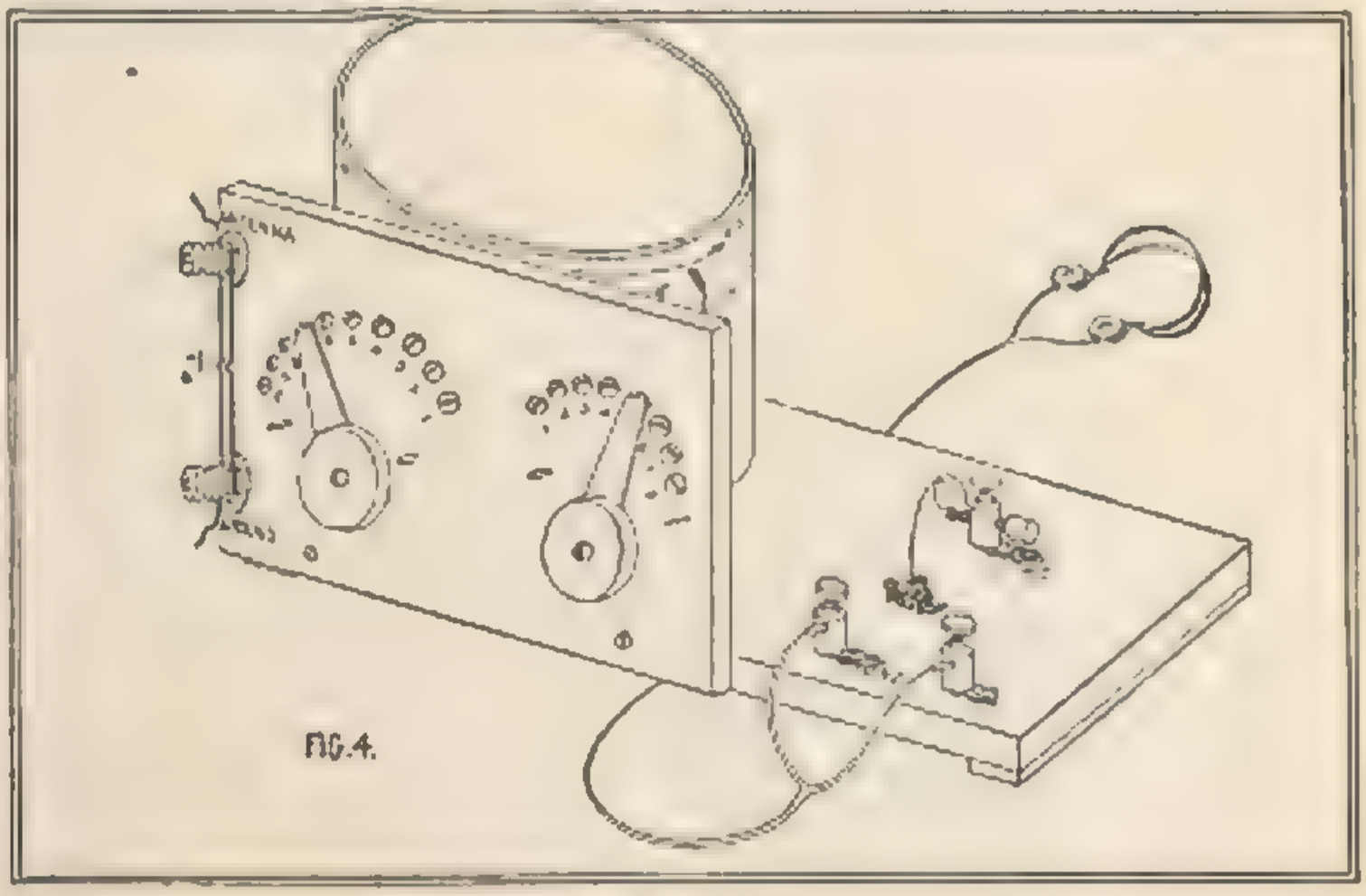
F is the antenna about 75 feet between the insulators E and G. The wire may be No. 14 or 16 copper wire either bare or insulated. The end of the antenna farthest from the receiving set may be secured to the insulator (E) by any satisfactory method, being careful not to kink the wire. Draw the other end of the antenna wire through the other insulator (G) to a point where the two insulators are separated by about 75 feet, twist the *insulator* (G) so as to form an anchor as shown in Figure 1. The remainder of the antenna wire (J) which now constitutes the "lead-in" or drop-wire should be just long enough to reach the lightning switch.

K is the lightning switch. For the purpose of a small antenna this switch may be the ordinary porcelain-base, 30 ampere, single-pole double-throw battery switch. These switches as ordinarily available, have a porcelain base about 1 by 4 inches. The "lead-in" wire (J) is attached to this switch at the middle point. The switch blade should always be thrown to the lower clip when the receiving set is not actually being used and to the upper clip when it is desired to receive signals.

L is the ground wire for the lightning switch; it may be a piece of the same size wire as used in the antenna, of sufficient length to reach from the lower clip of the lightning switch (K) to the clamp on the ground rod (M).

M is a piece of iron pipe or rod driven 3 to 6

Figure 4. The completed receiving set



feet into the ground, preferably where the ground is moist, and extending a sufficient distance above the ground in order that the ground clamp may be fastened to it. Scrape the rust or paint from the pipe before driving in the ground.

N is a wire leading from the upper clip of the lightning switch through the porcelain tube (O) to the receiving set binding post marked "antenna."

O is a porcelain tube of sufficient length to reach through the window casing or wall. This tube should be mounted in the casing or wall so that it slopes down toward the outside of the building. This is done to keep the rain from following the tube through the wall to the interior.

Figure 2 shows the radio receiving set installed in some part of the house.

P is the receiving set which is described in detail below.

N is the wire leading from the "antenna" binding post of the receiving set through the porcelain tube to the upper clip of the lightning switch. This wire, as well as the wire shown by Q, should be insulated and preferably flexible. A piece of ordinary lamp cord might be unbraided and serve for these two leads.

Q is a piece of flexible wire leading from the receiving set binding post marked "ground" to a water pipe, heating system or some other metallic conductor to ground, except M, Fig. 1. If there are no water pipes or radiators in the room in which the receiving set is located, the wire should be run out of doors and connected to a special "ground" below the window, which shall not be the same as the "ground" for the lightning switch. It is essential that for the best operation of the receiving set this "ground" be of the very best type. If the soil near the house is dry it is necessary to drive one or more pipes or rods sufficiently deep to encounter moist earth and connect the ground wire to the pipes or rods. This distance will ordinarily not exceed 6 feet. Where clay soil is encountered this distance may be reduced to 3 feet, while in sandy soil it may be increased to 10 feet. If some other metallic conductor, such as the casing of a drilled well, is not far away from the window, it will be a satisfactory "ground."

The detector and phone will have to be purchased. The tuner and certain accessories can be made at home.

Tuner (R, Fig. 3).—This is a piece of cardboard or other non-metallic tubing with turns of copper wire wound around it. The cardboard tubing may be an oatmeal box. Its construction is described in detail below.

Crystal Detector (S, Fig. 3).—The construction of a crystal detector may be of very simple design and quite satisfactory. The crystal, as it is ordinarily purchased, may be unmounted or mounted in a little block of metal. For mechanical reasons the mounted type may be more satisfactory, but that is of no great consequence. It is very important, however, that a very good tested crystal be used. It is probable also that a galena crystal will be more satisfactory to the beginner.

The crystal detector may be made up of a tested crystal, three wood screws, short piece of copper wire, a nail, setscrew type of binding post, and a wood knob or cork. The tested crystal is held in position on the wood base by three brass wood-screws as shown at 1 Fig. 3. A bare copper wire may be wrapped tightly around the three brass screws for contact. The assembling of the rest of the crystal detector is quite clearly shown in Fig. 3.

Phone (T, Fig. 3).—It is desirable to use a pair of telephone receivers connected by a head band, usually called a double telephone headset. The telephone receivers may be any of the standard commercial makes having a resistance of between 2000 and 3000 ohms. The double telephone receivers will cost more than all the other parts of the station combined but it is desirable to get them, especially if one plans to improve his receiving set later. If one does not care to invest in a set of double telephone receivers a single telephone receiver with a head band may be used; it gives results somewhat less satisfactory.

Accessories.—Under the heading of accessory equipment may be listed binding posts, switch-arms, switch contacts, test-buzzer, dry battery, and boards on which to mount the complete apparatus. The binding posts, switch arms and switch contacts may all be purchased from dealers who handle such goods or they may be quite readily improvised at home. There is nothing peculiar about the pieces of wood on which the equipment is mounted. They may be obtained from a dry packing-box and covered with paraffin to keep out moisture.

The following is a detailed description of winding the coil, construction of the wood panels, and mounting and wiring the apparatus.

Tuner.—See R, Fig. 3. Having supplied

oneself with a piece of cardboard tubing 4 inches in diameter and about ½ pound of No. 24 (or No. 26) double cotton covered copper wire, one is ready to start the winding of the tuner. Punch two holes in the tube about ½ inch from one end as shown at 2 on Fig. 3. Weave the wire through these holes in such a way that the end of the wire will be quite firmly anchored, leaving about 12 inches of the wire free for connections. Start with the remainder of the wire to wrap the several turns in a single layer about the tube, tightly and closely together. After 10 complete turns have been wound on the tube hold those turns snugly while a tap is being taken off. This tap is made by making a 6-inch loop of the wire and twisting it together at such a place that it will be slightly staggered from the first tap. This method of taking off taps is shown quite clearly at U, Fig. 3. Proceed in this manner until 7 twisted taps have been taken off at every 10 turns. After these first 70 turns have been wound on the tube then take off a 6-inch twisted tap for every succeeding single turn until 10 additional turns have been wound on the tube. After winding the last turn of wire, anchor the end by weaving it through two holes punched in the tube much as was done at the start, leaving about 12 inches of wire free for connecting. It is to be understood that each of the 18 taps is slightly staggered from the one just above, so that the several taps will not be bunched along one line on the cardboard tube. See Fig. 3. It would be advisable, after winding the tuner as just described, to dip the tuner in hot paraffin. This will help to exclude moisture.

Upright Panel and Base.—Having completed the tuner to this point, set it aside and construct the upright panel shown in Fig. 4. This panel may be a piece of wood approximately ½ inch thick. The position of the several holes for the binding posts, switch arms and switch contacts may first be laid out and drilled. The "antenna" and "ground" binding posts may be ordinary ⅛-inch brass bolts of sufficient length and supplied with three nuts and two washers. The first nut binds the bolt to the panel, the second nut holds one of the short pieces of stiff wire, while the third nut holds the antenna or ground wire, as the case may be. The switch arm with knob, shown at V, Fig. 3, may be purchased in the assembled form or it may be constructed from a thin slice cut from a broom handle and a bolt of sufficient length equipped with four nuts and two washers together with a narrow strip of thin brass somewhat as shown. The switch contacts (W, Fig. 3) may be of the regular type furnished for this purpose or they may be brass bolts equipped with one nut and one washer each or they may even be nails driven through the panel with an individual tap fastened under the head or soldered to the projection of the nail through the panel. The switch contacts should be just close enough so that the switch arm will not drop between the contacts but also far enough apart so that the switch arm can be set so as to touch only one contact at a time.

The telephone binding post should preferably be of the set-screw type as shown as X, Fig. 3.

INSTRUCTIONS FOR WIRING

HAVING constructed the several parts just mentioned and mounted them on the wood base, one is ready to connect the several taps to the switch contacts and attach the other necessary wires. Scrape the cotton insulation from the loop ends of the sixteen twisted taps as well as from the ends of the two single wire taps coming from the first and last turns. Fasten the bare ends of these wires to the proper switch contacts as shown by the corresponding numbers in Fig. 3. One should be careful not to cut or break any of the looped taps. It would be preferable to fasten the connecting wires to the switch contacts by binding them between the washer and the nut as shown at 3, Fig. 3. A wire is run from the back of the binding post marked "ground" (Fig. 3) to the back of the left-hand switch-arm bolt (Y), thence to underneath the left-hand binding post marked "phones." A wire is then run from underneath the right-hand binding post marked "phones" to underneath the binding post (4, Fig. 3), which forms a part of the crystal detector. A piece of No. 24 bare copper wire about 2½ inches long, one end of which is twisted tightly around the nail (the nail passing through binding post 4), the other end of which rests gently by its own weight on the crystal (1). The bare copper wire which was wrapped tightly around the three brass wood-screws holding the crystal in place is led to and fastened at the rear of the right-hand switch-arm bolt (V), thence to the upper left-hand binding post marked "antenna." As much as possible of this wiring is shown in Fig. 3.

After all the parts of this crystal-detector radio receiving set have been constructed and assembled the first essential operation is to adjust the little piece of wire, which rests lightly on the crystal, to a sensitive point. This may be accomplished in several different ways; the use of a miniature buzzer transmitter is very satisfactory. Assuming that the most sensitive point on the crystal has been found by method described in paragraph below, "The Test Buzzer," the rest of the operation is to get the radio receiving set in resonance or in tune with the station from which one wishes to hear messages. The tuning of the receiving set is attained by adjusting the inductance of the tuner. That is, one or both of the switch arms are rotated until the proper number of turns of wire of the tuner are made a part of the metallic circuit between the antenna and ground, so that together with the capacity of the antenna the receiving circuit is in resonance with the particular transmitting station. It will be remembered that there are 10 turns of wire between each of the first 8 switch contacts and only 1 turn of wire between each 2 of the other contacts. The tuning of the receiving set is best accomplished by setting the right-hand switch arm on contact (1) and rotating the left-hand switch arm over all its contacts. If the desired signals are not heard, move the right-hand switch arm to contact (2) and again rotate the left-hand switch arm throughout its range. Proceed in this manner until the desired signals are heard.

It will be advantageous for the one using this radio receiving equipment to find out the wave frequencies (wave lengths) used by the several radio transmitting stations in his immediate vicinity.

The Test Buzzer (Z, Fig. 3).—As mentioned previously, it is easy to find the more sensitive spots on the crystal by using a test buzzer. The test buzzer is used as a miniature local transmitting set. When connected to the receiving set as shown at Z, Fig. 3, the current produced by the buzzer will be converted into sound by the telephone receivers and the crystal, the loudness of the sound depending on what part of the crystal is in contact with the fine wire. To find the most sensitive spot connect the test buzzer to the receiving set as directed, close the switch (5, Fig. 3) (and if necessary adjust the buzzer armature so that a clear note is emitted by the buzzer), set the right-hand switch arm on contact point No. 8, fasten the telephone receivers to the binding posts marked "phones," loose the set screw of the binding post slightly and change the position of the fine wire (6, Fig. 3) to several positions of contact with the crystal until the loudest sound is heard in the phones, then tighten the binding post set screw (4) slightly.

APPROXIMATE COST OF PARTS

THE following list shows the approximate cost of the parts used in the construction of this radio receiving station. The total cost will depend largely on the kind of apparatus purchased and on the number of parts constructed at home.

Antenna		
Wire—Copper, bare or insulated, No. 14, 100 to 150 ft., about	0.75	
Rope—$\frac{1}{4}$ or $\frac{1}{2}$ inch, 2 cents per foot		
2 Insulators, porcelain	0.20	
1 Pulley	0.15	
Lightning switch- 30 ampere battery switch	0.30	
1 Porcelain tube	0.10	
Ground connections.		
Wire (same kind as antenna wire)		
1 Clamp	0.15	
1 Iron pipe or rod	0.15	
$\frac{1}{2}$ pound No. 24 copper wire double cotton covered	0.75	
1 Cardboard box		
2 Switch knobs and blades complete	1.00	
18 Switch contacts and nuts	0.75	
3 Binding posts—set-screw type	0.45	
2 Binding posts—any type	0.30	
1 Crystal—tested	0.25	
3 Wood screws, brass, $\frac{3}{4}$ inch long	0.03	
Wood for panels (from packing box)		
2 Pounds paraffin	0.30	
Lamp cord, 2 to 3 cents per foot		
Test buzzer	0.50	
Dry battery	0.30	
Telephone receivers	4.00 to 8.00 *	
TOTAL	11.00	15.00

If nothing but the antenna wire, lightning switch, porcelain tube, crystal, telephone receiver, bolts and buzzer are purchased this total can be reduced to about $6.00.

*Still more efficient and expensive telephone receivers are available at prices ranging to about $20.00.

CONSTRUCTION AND USES OF A LOOP RADIOPHONE TRANSMITTER

By ZEH BOUCK

THOUGH numerous articles have appeared extolling the advantages of the loop radiophone transmitter, to the knowledge of the present writer, no practical description of their construction and operation has been published. In discoursing on the subject many authors have emphasized (and not unduly) the directional effect of this type of transmitter and the resulting communicative possibilities due to the lessened QRM (interference). However, the radiation limitations necessarily imposed upon the loop by its electrical characteristics, make distances comparative with those secured with conventional antennas an impossibility except by a lavish expenditure of time and money upon ultra apparatus. For this reason, though I shall describe a transmitting loop capable of reliable communication over short distances, I shall rather emphasize the other adaptations of the loop as they appear under the general classifications of Novel Uses (magical illusions, etc.) and Laboratory Experiments.

For all three purposes the constructional details are identical, with the exception of the intercommunicative set, in which a slight elaboration of the basic type permits receiving and transmission with the same loop, tube, and tuning apparatus.

Before describing the set made and successfully experimented with by the author, it is well to mention that any wireless telephone at present radiating from an open antenna, can be easily transformed into a loop transmitter in either of two ways. The simplest, though probably less efficient method, is to substitute the loop in series with a variable capacity, for the ordinary aerial. In the second system the loop is used directly in place of the conventional inductance and where necessary, to sustain oscillations, a condenser (variable preferred) replaces the capacity afforded by the open antenna.

A glance at figure one will reveal that I have employed the second method wherein

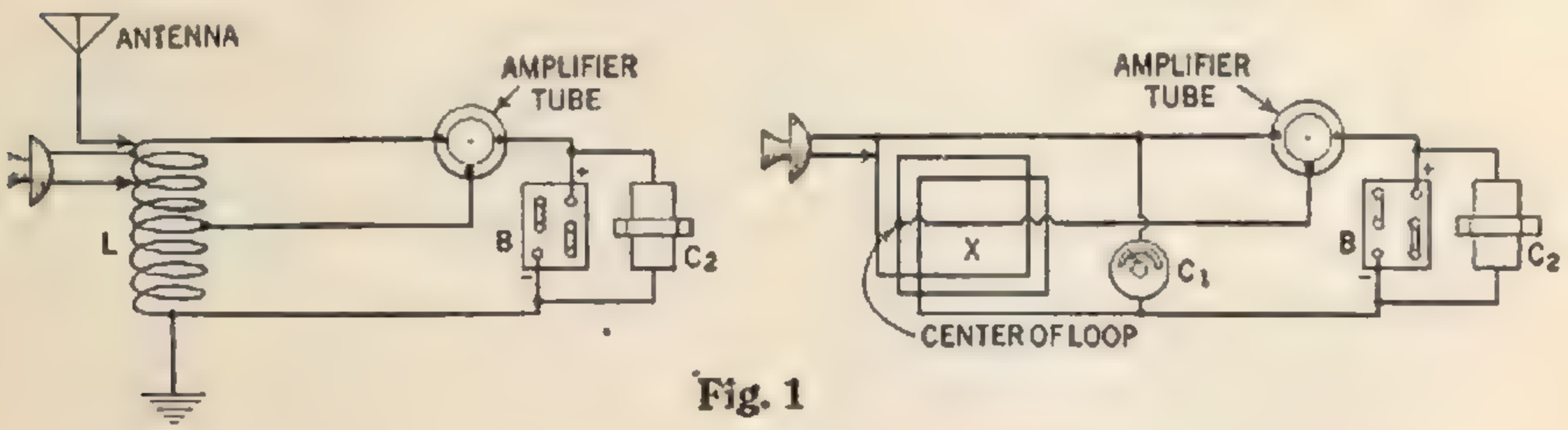


Fig. 1

the "Split filament circuit" has been superficially altered by the substitution of the loop X for inductance L and condenser C1 for the antenna and ground.

The loop was constructed on a twenty-inch square frame, and wound with seven turns of number twelve bare copper wire spaced three eights of an inch. The variable condenser C1 is of .001 maximum capacity, and the fixed permittance C2 (a bypass condenser) is the size generally shunted across spark coil vibrators. However, if such is unobtainable, or the experimenter contemplates employing a plate potential in excess of two hundred volts, he is advised to build up a condenser of thirty plates of 2″ by 2″ tinfoil separated by mica sheets.

The high voltage, B, may be a convenient source of D. C. over one hundred volts which in the case of portable sets will probably be found in block B batteries or a small dynamotor operative from a six volt supply.

Almost any amplifier tube of sufficient hard-

ness will operate successfully, and exceptional results have been obtained with Western Electric Vt's one and two.

Modulation of extraordinary quality is secured by shunting a partial turn of the loop by a microphone, one terminal of which is connected on the grid side of the loop while the other is clipped over that fraction of a turn (usually about one half) which gives best speech, i.e., the loudest voice without distortion or blocking of the set.

Constructional details will be immediately comprehended by reference to figure two. The

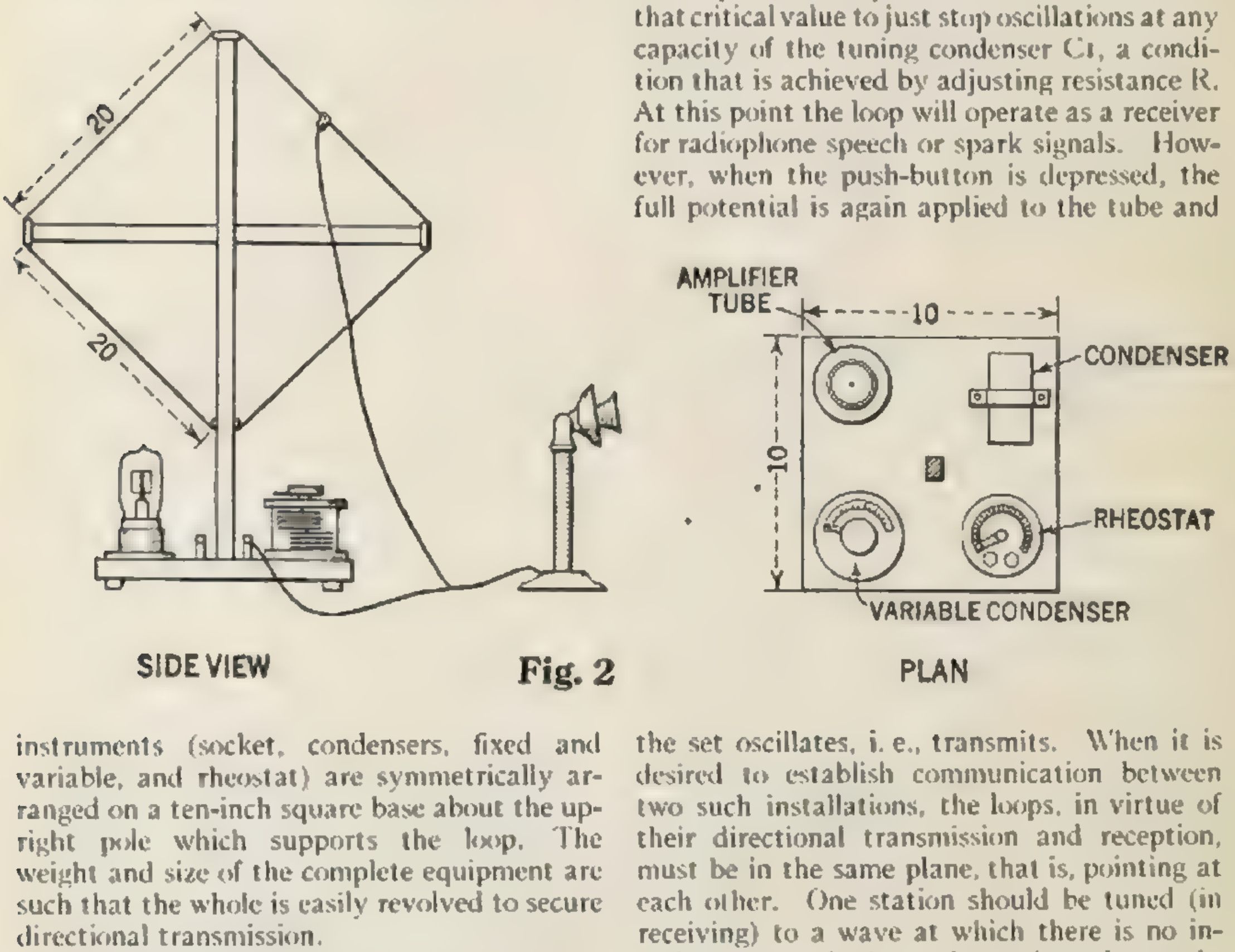


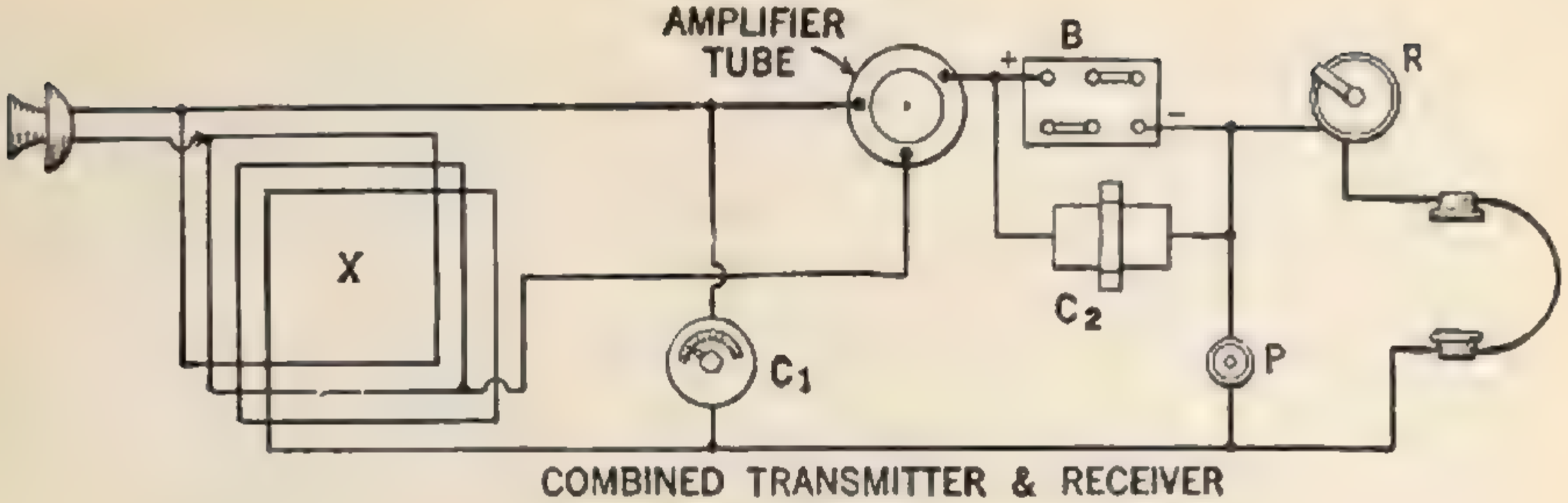
Fig. 2

instruments (socket, condensers, fixed and variable, and rheostat) are symmetrically arranged on a ten-inch square base about the upright pole which supports the loop. The weight and size of the complete equipment are such that the whole is easily revolved to secure directional transmission.

The experimenter will find many and varied uses for this apparatus in laboratory or research work, and I have used the set quite extensively as a calibrating wavemeter. To do this it is necessary to determine first the frequencies at which the transmitter oscillates at different capacities as indicated by the condenser scale. Employed in this manner, the set is extremely useful in calibrating other wavemeters and receiving sets. In the latter case it is advisable to dispense with the microphone and tune to a zero beat with the receiving set oscillating. The microaccuracy of this method is immediately apparent.

For intercommunicative work covering a distance which will vary directly with the applied plate potential from one to several blocks, the connections should be slightly altered so that they appear as in figure three. It will be observed in this circuit that a telephone headset and a high resistance potentiometer R, with the shunt push-button P, are placed in series with the high voltage. With the push-button released, the combined reactance and resistance of the phones and potentiometer should be of that critical value to just stop oscillations at any capacity of the tuning condenser C1, a condition that is achieved by adjusting resistance R. At this point the loop will operate as a receiver for radiophone speech or spark signals. However, when the push-button is depressed, the full potential is again applied to the tube and the set oscillates, i. e., transmits. When it is desired to establish communication between two such installations, the loops, in virtue of their directional transmission and reception, must be in the same plane, that is, pointing at each other. One station should be tuned (in receiving) to a wave at which there is no interference, and then, depressing the push-button, transmit and allow the other station to tune to resonance. Each station will now transmit and receive on the same wave. Boy Scout and similar organizations will doubtless find use for this set or those of like design.

By the addition of a set of the experimental type to his collection of props, the stage (or amateur) magician may add considerably to his repertoire of mind-reading mystifications. While it is obviously impossible to enumerate



COMBINED TRANSMITTER & RECEIVER

Fig. 3

or describe the legion adaptations in this line, I will mention one with which I have personally experimented.

The magician or mind-reader is consistently garbed in oriental attire, from his turbaned head which well conceals a pair of phones, to the flowing robes loosely enveloping him and a portable loop receiver of the design shown in figure four. The turns of wire, both the loop and single tickler turn (which should be separated by at least an inch), are easily interwoven through the thirty-six-inch circumference of the burlap band. The upper elastic belt serves to hold the loop in position about the performer's waist. The receiving bulb is preferably a tubular one which will slip easily into a pocket. The elastic belt will also support the filament flashlight batteries and two conventional .0005 condensers, the one in the grid circuit being supplied with a leak. As in the portable transmitter-receiver, the potentiometer R must be varied until the bulb is just below the oscillation point. All tuning is of course accomplished by the variable condenser across the transmitting loop.

The illusion is perfect!

An assistant passes out slips of paper among the audience with the request that they write thereon any question they may desire answered. Upon collecting them he apparently turns the slips over to his *Blindfolded* master and exits. The magician holding each slip of paper before his bound eyes then gives relevant answers to every question! The secret is simple. The papers handed the magician are blanks, those upon which the questions are really written being retained by the assistant who, retiring to the wings (or even to the dressing room) reads them via radiophone, to the turbaned sorcerer!

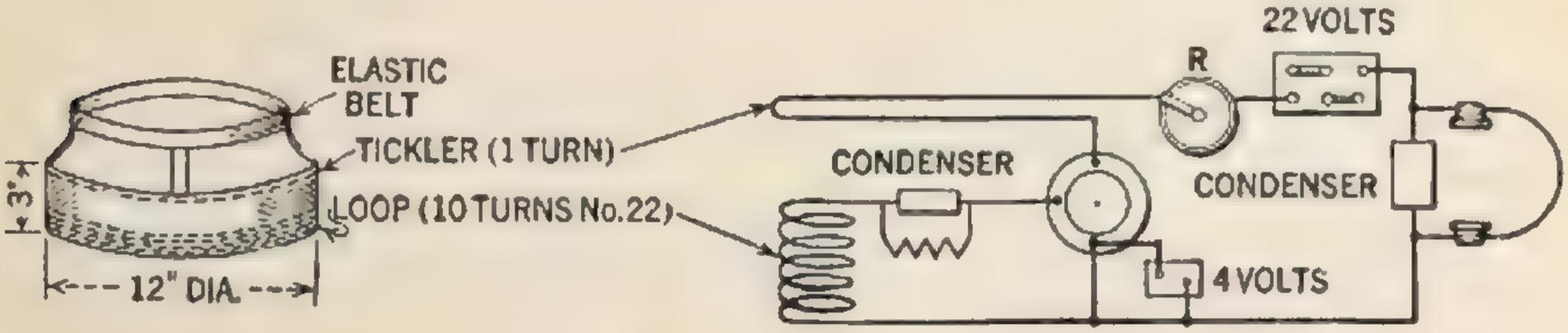


Fig. 4

A COMPACT PORTABLE WIRELESS SET

A Complete Wireless Telephone Transmitting and Receiving Station Which May Be Carried by a Single Boy Scout

By ARTHUR H. LYNCH

IT IS doubtful if any one subject studied by Boy Scouts is as popular as radio. This was true even before radio broadcasting was introduced, creating the nationwide interest it has. In the days when it was necessary to communicate by code, many instances arose which clearly demonstrated that Scouts were able to render great service to mankind not to mention the enjoyment they derived from the pursuit of this very attractive hobby.

In times of flood and other disaster, where the telephone and telegraph wires have been demolished, communication has been made possible and relief brought by radio outfits operated by Scouts. During the European War the work done by the Scouts is now a matter of history with which most folks are familiar, but the work of yesteryear is now being far outranked, and what is considered exceptional to-day is seemingly destined to be the commonplace of to-morrow.

For instance, who, a year ago, would have thought that a complete wireless telephone station, with its source of power, the necessary wire for the aerial and ground systems, transmitter and receiver, could be limited in weight to approximately fifteen pounds and could be conveniently carried in a single haversack? Surely there were few such folk.

It was but a few years ago, when the U. S Army pack transmitter was introduced and caused a great furor in radio circles. It was made up in several units and could be carried from place to place by mules. There were collapsible masts and the spark transmitting unit and the generator unit and the receiving unit, each designed to fit snugly on the back of a mule. The generator was provided with two handles, somewhat similar to those on a coffee mill, and two husky men were kept quite busy cranking up enough "juice" to run the transmitter, which, by the way, had a very limited range. More recent models have been perfected by the Army and one set was made for use in France. However, there were no complete stations in the war which could be counted upon to perform as the little complete station which is now available for Scout use.

THE "STATION" EQUIPMENT

IF THE apparatus in the accompanying illustrations is compared in size with the boys surrounding it, little need be said regarding its compactness, and misgivings are likely to present themselves as to the possible value of such a small outfit. In order to make this point very clear let us consider some past performances, just as soon as we have covered the parts which go to make up the "station."

First and foremost, there is a regenerative tuner, with a single wave length control and a tickler control. Wherever we find a regenerative circuit we must have vacuum tubes, and in this particular receiving set there is a tube of special construction, designed to operate from the power delivered by a single dry battery of the type ordinarily used for door bells. There is a rheostat, or regulating resistance, connected in this battery circuit, and adjusting it permits variation of the current flowing through the tube in order that any desired intensity may be secured.

Vacuum tube operation requires the use of a "B" or "plate" battery, which in this case is in the form of a block just about one third the size of a common red brick. This little battery is made up of a number of individual dry cells in series and is designed to supply a high voltage rather than much power. Such batteries may be counted upon to supply approximately twenty volts, which is sufficient for the plate circuit of the vacuum tube used in this outfit.

Of course it is necessary to employ telephone receivers, though this set may be used with amplifiers and a loud speaker when it is used in a permanent location rather than in field work. Except for the aerial and ground wires, which we will consider more thoroughly presently, there is nothing else needed for this transmitting and receiving station. Let us

THE PORTABLE RECEIVING OUTFIT
Which also can be used as a radio telephone transmitter. Current for the operation of the vacuum tube is supplied by a single dry cell

now consider its ability to receive, leaving the transmitting for consideration anon.

A PHENOMENAL RECEIVER

WE HAVE become so used to thinking of radio in terms of kilowatts, and towers and what-not, that the suggestion of a really compact receiving outfit, operating from a single dry cell being of much value does not seem very likely, but in this instance we have erred.

Many of these receiving outfits are now in use and there is nothing more interesting than putting one of them through its paces, for an agreeable surprise is generally the result. For instance, there is a gentleman in Jersey, who could not tell one letter of the code from another, were it to be transmitted to him at five words a minute, nor does he know the difference between a condenser and an inductance, and his ideas concerning wave length could never be found in any book on radio, for he hasn't any, but he has installed one of these receiving sets. The aerial this gentleman boasts is a single copper wire, about eighty feet long and thirty or thirty five feet above the ground. Would it surprise you to know that he was able to receive wireless telephone speech very clearly from a vessel nearly a thousand miles at sea, during the day?

There are a number of similar installations in Brooklyn and it is quite a common thing for these stations to listen to the transmitting from the broadcasting station, located in East Pittsburgh, Pa., even though no effort is made to instal pretentious aerials. Most of those which have been observed are of the single or two-wire type, generally fifty to one hundred feet in length. With such a receiver is it strange that a new era has dawned in Scout communication?

AN EXCEPTIONAL TRANSMITTER

AFTER considering the wonderful improvement in radio receiving apparatus, which now makes it possible for us to listen to wireless telephone conversation over distances of many miles, with very simple equipment, it is even more astounding to learn that this same outfit may be converted into a transmitter by merely making an adjustment or two, removing the receivers from the head, and talking into one of them.

In order to transmit, it is necessary to have the bulb oscillating and this condition may be recognized by a mushy sound in the telephone receivers. When this occurs, it is merely necessary to talk into one of the telephone receivers and the speech, thus transmitted may be picked up over short distances. A low resistance microphone placed on the ground lead will give slightly better results.

It is not necessary to throw any switches in transferring from transmitting to receiving, but it is necessary to alter the "tickler" knob a little, in order to cut out the mushy sound when reception is being carried on. If this were not done, the incoming speech or telegraph waves would be distorted and in the case of the former, might be unintelligible.

FIELD OPERATIONS

SCOUTS on field manœuvres may conveniently carry one of these stations with them, and where several troops are to be directed from a single headquarters, it is generally found advisable for the headquarters station to be equipped with a more powerful transmitting station, while the various troops may

communicate between themselves by employing the small portable "stations" we are considering. Signals from headquarters may be received over rather long distances, depending, of course, upon the power at the transmitting station and such other variable factors as the size and height of the receiving antenna and the particular natural characteristics of the land over which the communication is carried on.

The most important consideration in field operations is the aerial, or "antenna" as it is sometimes called. There is a great deal of misunderstanding concerning this very important part of a radio station, so let us decide this case once and for all. Perhaps we may best know what to do by knowing what not to do.

For ordinary communication a wave length of two hundred meters should not be exceeded, therefore the best form of aerial is a single wire, having a total length, from the binding post on the set to its outer end, of about fifty feet.

This wire may be made of almost any metal and may be bare or insulated. For outdoor work, the best aerial wire is aluminum, because it is very light, but it is rather brittle and requires a little care in handling, which is not the case when copper or galvanized iron wire is employed. If the additional weight makes no difference, copper is most suitable.

RECEIVING MESSAGES FROM TROOP HEADQUARTERS

The equipment shown in the previous picture in operation. No ground connection was possible so an insulated wire thrown on top of the snow was used as a counterpoise

Various locations require aerials of different classes, but no definite rules may be given, governing this phase of field radio communication and the following generalities may be followed, as nearly as is reasonably possible, with satisfaction.

Wherever possible, the aerial should be very well insulated and should be isolated from all possible surrounding objects. A very suitable aerial may be erected in a few minutes by attaching an insulator to a string and casting the insulator over a high tree, letting the string unravel as the insulator takes its course, in somewhat the same fashion as the gun used for life-saving purposes. A little practise is necessary for this work, but it is not a very difficult task for a boy to cast a line over the top branch of a fifty foot tree.

When the insulator comes down, on the opposite side of the tree, it is merely necessary to fasten one end of the wire to it, pull in on the string until the insulator is in a position approximately fifteen feet from the leaves, drive a stake in the ground and make the string fast to it. The remaining end of the aerial wire should then be connected to the outfit and drawn up taut. The ideal condition is found where there is a single tree without foliage, but if an effort is made to keep the aerial wire as far from other objects as possible, this ideal condition is not entirely necessary. In making the aerial do not make the very common mistake of using too long or too many wires. More than two should not be used, nor should the aerial be more than fifty feet in length, for this class of communication.

Wherever possible, advantage should be taken of a natural ground connection, that is, one in which it is possible to place a large sheet of metal directly into some body of water or soggy soil. If it is possible to locate a water pipe it is doubtful that a more suitable ground could be had. A water supply hydrant is frequently available along most of our highways.

Where use is to be made of the natural ground, a sheet of metal approximately one foot by three feet should be buried in moist earth after a wire is soldered to it or attached by a binding post. The latter method is frequently found more convenient. Where operation is to be carried on over a stretch of dry territory and it is impossible to locate a water pipe or some soggy ground, it is necessary to employ what is known as a counterpoise. A very con-

A BOY SCOUT TROOP EQUIPPED WITH RADIO

The scout with the knapsack has in it the complete wireless telephone transmitting and receiving station, including the necessary tuning apparatus, telephone receivers, batteries for power, aerial and ground wires

venient counterpoise may be made by a single piece of insulated copper wire 40 or 50 feet in length, laid directly above the earth in approximately the same direction the antenna extends. However, the direction of this wire is not of very great importance. Where possible a more suitable arrangement may be had by raising this counterpoise wire approximately one foot above the ground, by means of stays driven into the earth.

"THE STATION" IN OPERATION

THIS type of set is supplied with complete instructions for installing and operating, but since we have attempted using this outfit for transmitting as well as receiving, one or two points must be considered in order to have it operate satisfactorily.

Stations communicating back and forth by this simple method of wireless telephony should operate on approximately the same wave length. By doing this the change from a suitable receiving condition to the proper transmitting condition is effected by merely rotating the tickler control knob. Best wireless telephone reception is accomplished when the receiving set is brought to a point just below oscillation, whereas transmitting may only be carried on satisfactorily where oscillation actually exists. The most convenient method for bringing about this change is, as we have said, rotation of the tickler control knob. Transferring back and forth may be done very freely after a little experience is had in connection with this outfit and very rapid transferring of thought between Scout Troops is now possible.

With the approach of good weather, Scout manœuvres will undoubtedly be increased and their scope made much broader by an intelligent application of radio telephony.

RADIO NOTES FROM HOME AND ABROAD

PUBLIC INTEREST IN RADIO

PROBABLY the sensation of the New York radio show in March, the second annual exhibition arranged by the Executive Radio Council of the Second District, was the interest of the public in the event. The show was housed on the roof of the Pennsylvania Hotel. After the first night it was decided that Madison Square Garden would have been hardly adequate. Thousands went to the show and more thousands were turned away, and those who got in were frequently as disappointed as those who failed, for the exhibition room was generally so crowded that the spectator couldn't see the exhibits and the exhibitor couldn't satisfactorily explain to the spectator.

All of which isn't exactly a criticism of the promoters of the show. Their past experiences had led them to believe that the exhibition would attract the amateur chiefly; they were unprepared, as all branches of the radio industry were unprepared, for the sudden great development of interest in the art.

Viewed as a whole, the show was noteworthy as indicating the belief of manufacturers in the permanency of broadcasting and the permanency of public interest. The tendency among producers of radio equipment is toward a compact receiving set in cabinet form which will take its place without criticism among the furnishings of the home. Loose ends, loose wires are steadily being eliminated. The loud speakers generally didn't make an entirely satisfactory impression. Some were good, but there was much evidence of throat trouble; one of them was usually yowling regularly. Before the next show the manufacturers should be able to exhibit reliable loud speakers. Otherwise they had better be left at home.

The Executive Radio Council, which arranged the show, is an organization of amateurs, and, notwithstanding their failure to gauge the extent and amount of public interest, they are to be congratulated for their efforts to make the exhibition representative and instructive. J. O. Smith, chairman, and the following members of the council comprised the exhibition committee: Renville H. McMann, M. Blun, Carl E. Trube, C. B. Hobson, C. J. Goette, A. F. Clough, John D. Blasi, F. B. Ostman, W. J. Howell, H. Hertzberger, J. B. Ferguson, B. B. Jackson, F. L. McLaughlin, J. J. Kulick, C. E. Huffman.

A Giant Belgian Radio Station

A 500-kilowatt radio station is being erected at Ruysselede near Bruges, by the *Societe Independante Belge de Telegraphie Sans Fils.* It will be able to communicate with North and South America, as well as with the Congo in Africa. It will be possible to receive four messages simultaneously. Another big radio station is to be erected by the Government in the Congo.

Radio Broadcasting in Holland

THE broadcasting idea is steadily gaining ground in Europe, although it is well to point out that the service there is of a more commercial nature than its American counterpart. In Germany the radiophone has been in use for some time for the distribution of business reports. Now we learn from the *New York Times* that a radio-phone news service has been inaugurated in Holland, with excellent results. Fifty different newspaper subscribers of the Vasdiaz Agency at Amsterdam, equipped with a simple receiving apparatus, have been receiving the news reports.

This is considered only the commencement of wireless telephone for journalism in Europe. Although not yet extended abroad, this service will undoubtedly follow. International laws requiring special governmental permits for sending and receiving messages abroad are at present the only obstacles.

The Vasdiaz Agency received congratulatory messages from the Dutch Ministers and authorities and also from foreign government officials, including Premier Lloyd George. The Hague papers obtained excellent results in transmission by the new wireless telephone.

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AN AMATEUR RADIO CONVENTION

The members of the first amateur radio convention from the states around the District of Columbia at the Arlington Station

Messages sent out from Amsterdam can be received by the whole of Holland.

Radio and Airways

RADIO and aviation go hand in hand. Certainly, aviation on anything like a practical scale needs radio, and needs it in the most emphatic sort of way. So it is not surprising to learn that the Army Air Service is now engaged in constructing and installing permanent radio stations at Mitchell Field, Long Island; Langley Field, Hampton, Va.; Langin Field, Moundsville, W. Va.; and Wilbur Wright Field, Fair-field, O. Those at Moundsville and Fairfield are to be spark sets of 5-kilowatt capacity, while those at Mitchell Field and Langley Field will be continuous wave tube sets of approximately 3-kilowatt capacity. The purpose of these stations will be to keep airmen posted as to weather conditions existing along their routes. According to Captain Oliver S. Ferson, it is hoped that the inauguration of this system of inter-communication between Air Service fields and stations will obviate the possibility of a recurrence of accidents similar to that which occurred at Morganville, Va., when a number of lives were lost as a direct result of an airplane flying into a storm of which it had no previous knowledge. The Air Service contemplates the extension of this radio set to include eventually every Air Service field and station in the United States.

The Beginning of Radio Broadcasting in England

THE first of a series of regular wireless telephone transmissions, as radiophone broadcasting is called by our British cousins, took place recently, for the benefit of the English radio amateurs. The Marconi Scientific Instrument Company prepared a fifteen-minute musical programme for the occasion. The first telephone selection was radiated from the Marconi station at Writtle on a wave length of 700 meters. This was preceded by a series of radio telegraph signals for calibration purposes on 1,000 meters. The power employed for radio telephony is limited to 250 watts in accordance with the terms of the Post Office license.

Operating Vacuum Tubes on Alternating Current

SOONER or later the radio enthusiast who has a working acquaintance with vacuum tubes wonders why vacuum tubes cannot be operated on lighting current, thereby doing away with the necessity of storage batteries. The truth of the matter is that the slightest variation in the filament current makes a corresponding noise in the telephone receivers. Alternating current and direct current fluctuate, especially the former; hence their use results in noises in the telephone receivers. It has remained for Prof. Marcel Moye of the University of Montpellier, France, to conduct an investigation with vacuum tubes with a view to utilizing alternating or direct current. The problem is a difficult one, but this French investigator appears to have made some very substantial progress by way of ironing out the irregularities of the current, so to speak. Space does not permit us to state here just how Prof. Moye accomplishes the final result, but suffice it to state that he makes use of resistances, variable condensers, and a crystal detector, arranged in a very delicately balanced circuit. Indeed, after considering the layout of equipment necessary to operate vacuum tubes on a lighting circuit, one comes to the conclusion that it is perhaps best, after all, to be satisfied with storage battery operation.

Britain's New Radio Station

FACTS are now available concerning the new British station at Leafield, England, located about 600 feet above sea level. The power plant consists of two 250-kilowatt arcs and auxiliaries. The main aerial system is supported on ten tubular steel masts, each 300 feet high. The ground wires are buried at a depth of about 9 inches. For reception a separate aerial, supported on 75-foot poles, is to be used. It is necessary for this aerial to be grounded and the receiving apparatus protected during transmission on the main aerial. This operation is performed by a remote-controlled switch, which is operated by the stop on the arc controller immediately preceding the stops operating the 1,000-volt contactors of the arc supply current.

GETTING BASEBALL RESULTS ABOARDSHIP IN THE GULF OF MEXICO

A combination of radio and a typewriter will soon spread the news to all the ship's company

© Underwood & Underwood

ONE OF THE ATTRACTIONS AT THE NEW YORK RADIO SHOW
E. R. Glavin with his wireless controlled wagon which ran about delivering mail and papers

Radio and the French Farmer

METEOROLOGICAL forecasts to twelve districts in France are now being sent daily from the Eiffel Tower for the benefit of farmers. They will indicate the weather for the following day, the direction of the wind, the state of the sky, and the possibilities of dangerous phenomena for agriculture, such as frost, storms, hail, and so on, and the variation of temperature. The messages will be transmitted at 4:30 p. m. daily, and in summer it is intended to send a second message at daybreak. This will contain the same information, only the minimum temperature of the night will be replaced by the maximum temperature of the day.

Atmospheric Conditions and Radio

METHODICAL experiments for discovering a relation between atmospheric conditions, particularly atmospheric pressure, temperature, dampness, wind, potential gradient, number of ions, atmospheric current in the antenna, and so on, and the quantity and intensity of atmospherics, as well as fading of signals, were made by S. Wiedenhoff, a German investigator, and are reported in a recent issue of a German technical periodical. The chief conclusions are as follows: (1) The maximum variations in atmospherics are observed when the variations of the potential gradient are minimum and when the atmospheric current in the antenna and the number of ions in the air are maximum. (2) In general no atmospherics, or only a few, are experienced in conditions of dry fog, but they immediately appear so soon as fog is dissipated. (3) Rain, diminution of potential gradient and of the number of particles of dust produce great atmospheric disturbances. (4) Increase of atmospheric current in the antenna produces a sensible diminution of atmospheric disturbances.

So far as the regular and periodic variations in the intensity of atmospherics in day time (maximum in the afternoon, minimum in the morning), and during the year (maximum from June to September, minimum in February) are concerned, the following conclusions were arrived at: (1) The largest number of atmos-

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AN AMATEUR STUNT

A Match Box Receiver and Its Twelve Year Old Maker. A striking example of the interest of radio for boys

pherics is obtained when the vapor pressure is maximum at the earth's surface, when the conductivity of the air increases and when the velocity of the wind diminishes. (2) The number of atmospherics is minimum when the air conductivity is maximum at a certain height, when fog or great relative damp is present, when the temperature is minimum, and atmospheric pressure is maximum. (3) The number of atmospherics increases when the potential gradient increases.

As to the fading of signals, it was found that the intensity of signals increases when the atmospheric pressure and the wind increase, and when the temperature diminishes.

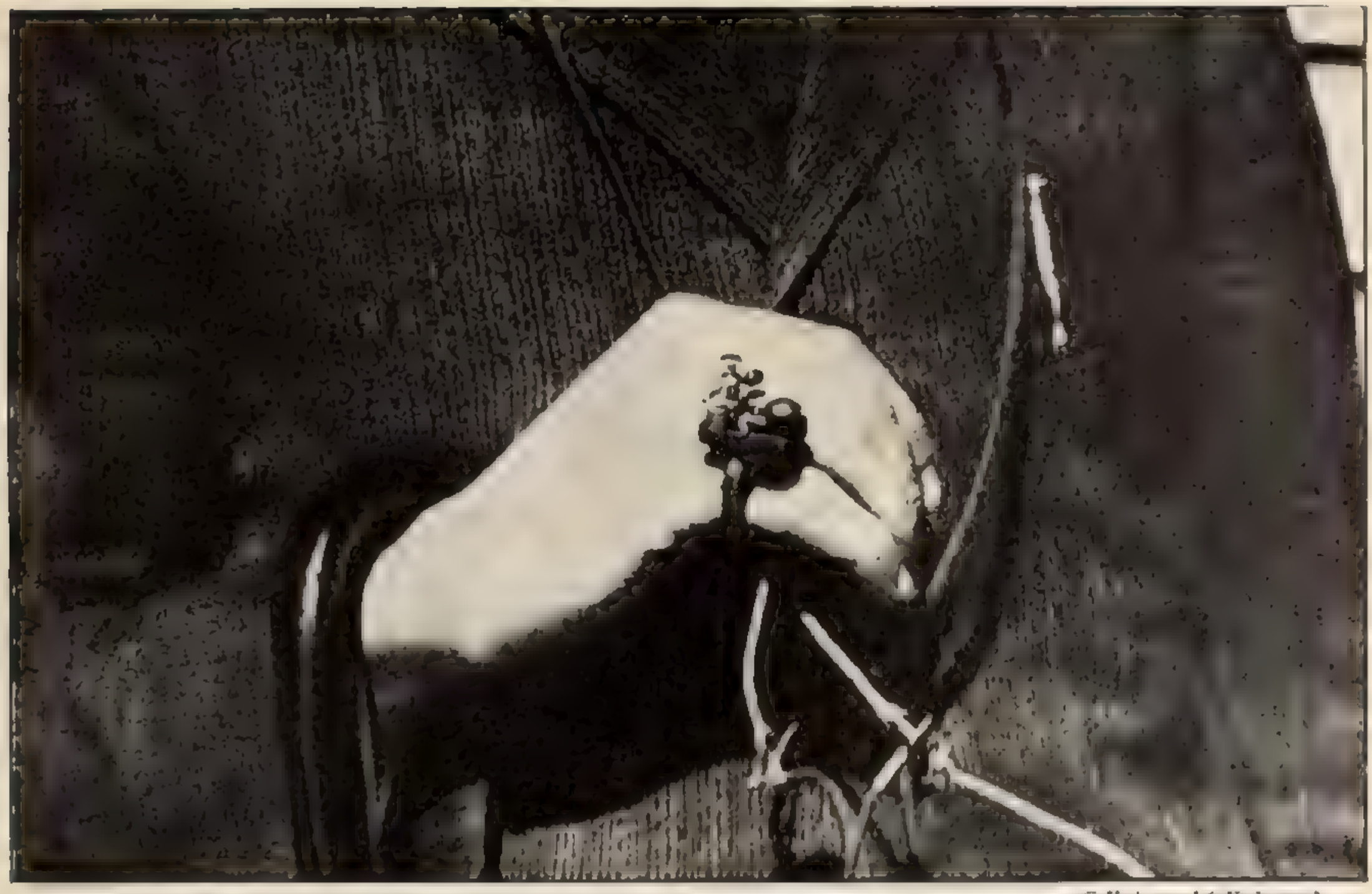
The Radio Cable and Airships

THE time may yet arrive when aircraft pilots will guide their ships of the air by means of their ears rather than their eyes. At least experiments have recently been conducted in France with the radio cable as a means of guiding aircraft, just as the same idea is now in use for the purpose of aiding steamship pilots in and out of narrow waterways such as harbors.

The recent experiments were conducted at the Villacoublay airdrome, and use was made of a discarded power line for the radio cable. Alternating current of 600-cycle frequency was sent through the transmission line so as to set up the desired magnetic field. On board the aircraft three simple loops of wire are employed, two of them placed vertically and one horizontally. In the cases of the usual

IN THE RADIO ROOM OF A DAILY NEWSPAPER

Getting news despatches direct from Europe. The code messages are copied on the automatic recorder shown in the centre of the picture and later transcribed by operators by a method similar to that of a dictating machine



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A MINIATURE RECEIVING SET

Made in the shape of a ring. An ordinary umbrella is used as antenna—an interesting plaything for those versed in Radio

airplane, the loops are placed at the end of the machine and form part of the tail construction. The two vertical loops, one of which is placed longitudinally and the other right angled to the direction of flight, tell the direction of the cable. When the aircraft is moving directly over the charged cable, the humming of the alternating current is heard loudest in the telephone receivers worn by the pilot. The more the aircraft deviates from the path of the cable, the weaker becomes the hum. The other vertical loop, on the other hand, operates in just the opposite manner; the hum is loudest when the aircraft is at right angles to the cable. By switching from one to the other, the aviator can pick up the cable and follow it along by means of sound.

The horizontal loop is used at high altitudes to explore for the guiding charged wire. The cable can be picked up at 10,000 feet. However, the aircraft must be within 6,500 feet before the cable can be followed.

Ultimately, radio cables must come into use for guiding aircraft, especially at night and during foggy weather. Cables leading in different directions can be supplied with alternating currents of varying frequencies in order to distinguish one route from another.

The Radio Telephone Where Wires Will Not Go

RADIO communication is being employed by a southern California light and power company between one of its power plants and the main office, a distance of 125 miles. Another light and power company is employing portable radio telephone sets for keeping in touch with camps in the mountain territory where extensions are in progress. Vacuum tube sets are employed in each case and the results are reported to be satisfactory under all conditions. Trials are in progress of portable sets with a 25-mile range for communication between the various construction camps.

LEAVING THEIR MONUMENTS IN THE ETERNAL ETHER

Stories of Radio Men at Sea

By PARKHURST WHITNEY

SOMEWHERE in the Atlantic seven hundred miles off Cape Race lies the body of the wireless operator of the little Norwegian freighter *Grontoft*, lately bound from Norfolk to Esbjerg. With him lie the bodies of the other nineteen members of the crew. His name is unknown; but what he said while his wireless still crackled, the manner in which he met his fate, is bound to live in the annals of the sea. He was of the pure breed of men who take their chances with the gods of the storm.

One of the fiercest gales of a wild winter was turning the Atlantic on end one day last March as the Baltic liner *Esthonia* labored westward toward Cape Race. Great waves were burying liners under mountains of water. Two hundred miles westward from the *Esthonia*, the Cunarder *Cameronia* had just been raked fore and aft by the largest wave that Captain Blakie had seen in his thirty-five years at sea—a wave forty feet high and three hundred feet broad from trough to trough. It was that sort of day.

In the wireless room of the *Esthonia*, Edward Hanson, the operator, sat braced at his desk listening to the sputtering of other wireless operators as they retailed astounding details of the size and volume of the waves that were sweeping over their ships. At 10 o'clock in the morning Hanson picked up an SOS. It was from the freighter *Grontoft*. The call came in the usual form, giving, as regulations specify, the position of the ship, which was forty-eight miles northeast of the *Esthonia*. This done, the operator aboard the freighter added:

"God pity the boys at sea on such a night as this. The old man thinks it might breeze up by night."

There was a pause and Hanson's apparatus flashed back a response to the call. Then he dropped his receiver and notified Captain Hans Jorgenson, of the *Esthonia*. The *Cameronia* had also picked up the appeal for help, but she was two hundred miles away. It was up to the *Esthonia* and Captain Jorgenson didn't falter, though his ship dropped sickeningly between two great walls of water as she put about. She trembled under the shock of a broadside of water and edged shivering into the wind as the screw raced and a huge comber heaved at her keel.

"Tell him," said Captain Jorgenson, "that we are on our way."

Hanson went back to the wireless room and sent the cheering message. The *Esthonia's* engines were put under forced draught, but such was the power of wind and wave on that day that she only made four miles in the first hour. At times her screw was hoisted clear of the water. Another SOS came from the *Grontoft*. At the end the operator tacked on his usual cheerful, ironic observations.

"Well," he said, "the steward is making sandwiches for the lifeboats. Looks like we were going on a picnic."

The picnic to which he referred was a gale in which no small boat could survive, even if it should happen to drop right side up from the davits. Hanson sent an encouraging message as the *Esthonia* drove on, picking up a little speed as she headed into the wind. Half an hour later the *Grontoft* operator sent out another of his cool comments. His ship was doomed, and so were the men aboard her, but he chose to jest about it as usual.

"The old wagon has a list like a run down heel," he said. "This is no weather to be out without an umbrella."

"Hold on, we'll be alongside soon," Hanson flashed back.

Then for a time there was silence while Hanson waited and other operators queried Hanson as to what he thought his ship could do even if she did come alongside the freighter. Hanson paid no attention to these messages; he was waiting for word from the gallant man in the wireless room of the *Grontoft*. It came

at noon, the first part of it dictated by the captain.

"We are sinking stern first," it said. "The decks are awash. The boats are smashed. Can't hold out any longer."

To this laconic farewell of another seafaring man, the operator added, as though he wished to assure Hanson that he wasn't unduly troubled: "The skipper dictated that. He ought to know. . . . Where did I put my hat? Sorry we couldn't wait for you. Pressing business elsewhere. *Skoal!*"

There was no more. Not so much as a bit of wreckage was visible at four o'clock in the afternoon when the *Esthonia* arrived on the scene. The *Grontoft* and her crew and her dauntless operator had indeed gone to pressing business—elsewhere.

Since that day in January, 1909, when Jack Binns used the wireless to save the passengers and crew of the White Star liner *Republic*, the world has come to expect great deeds of the men who ride the hurricane deck with receivers clamped to their ears. Nor has the world been disappointed. Sometimes they fail, as the operator of the *Grontoft* failed, because there are times when the elements are too much for man and his machines. More often they succeed. Their work is not always dramatic. The history of disasters at sea fortunately is not of a succession of *Republic* and *Titanic* affairs. It is the every-day routine duty of the radio that robs the sea of much of its terror. Radio frequently beats the heaviest storms of their toll of life; in fairer days it brings a sense of security and ease to all who travel on ships.

Sometimes the amateur takes a hand at rescue work. Three Brooklyn men went fishing one day last fall out in the Atlantic near the Ambrose lightship. When they started for home late in the afternoon they discovered that a leak in the gas feed pipe had nearly emptied the gas tank. They had oars, but the seas were rising and they could make little headway. Despite their combined efforts at the oars they drifted steadily toward the open sea in a twenty-six foot motor boat. They spliced two anchor lines together, but the line parted. Again they drifted seaward. Night came and they signalled the lightship with a lantern, but without success. Through the night they continued to drift with only a half filled water jug for nourishment. At two o'clock in the morning they saw a brightly lighted passenger ship pass within two hundred yards without noticing them. Dawn came and they observed the *Hudson* of the United States lines and the *Lackawanna Valley*, a freighter, and hailed them without success. At noon another freighter came into view and seemed to head toward them. The men exhausted themselves trying to attract her attention, but she sheered off.

They were weak with hunger and exposure. Their motor boat was now about thirty miles southeast of the Ambrose light and far out of the lane of frequent travel. The boat was half full of water and her seams were beginning to open. They realized that their situation was desperate.

Then the steamer *Nantucket* came over the horizon, made for them, and picked them up. The night before a young brother of one of the men had become worried over their absence and had gone to a small wireless station operated by an amateur. A message sent out from that station was picked up by a wireless station operated by another amateur out on Rockaway Beach. From there it was relayed to the Atlantic and picked up by the *Nantucket*.

PRACTISING MEDICINE BY RADIO AT SEA

RADIO has brought a new idea into the practice of medicine—the long-range operation. Late one night the wireless operator at the Bush Terminal building in New York City sat at his desk and picked up a message from the captain of an oil tanker out in the Atlantic. One of the crew had cut his hand on a piece of wire a few days before; it had become infected and the man was suffering acutely. There was no surgeon aboard and an immediate operation seemed necessary. A heavy sea was running and it was impossible to transfer the man from the ship. The tanker's wireless was searching the ether for help.

The wireless operator at the Bush Terminal decided to take a hand. He telephoned to Dr. Raymond Barrett, of the Brooklyn Hospital, at his home and got his coöperation. Then he sat at his apparatus and transmitted directions between the physician at his home in Brooklyn and the tanker rolling in the Atlantic. There was a member of the crew who had had some experience as a nurse. To him the operator sent Dr. Barrett's directions about accessories for the operation, the making of bandages and drainage tubes. A herring

knife was sterilized, to be used as a scalpel. Drainage tubes were made from pieces of rubber. Then, while the doctor sent directions through the ether, the operation was performed, without anæsthetics, but nevertheless successfully.

On a recent voyage of the United States liner *America* a wireless message came from a Shipping Board freighter to the effect that nineteen members of the crew of thirty were suffering from a mysterious and painful malady. The vessels were three hundred miles apart, but from the information wirelessed to the *America*, Dr. C. F. Leidy and Dr. Hislop diagnosed the disease as ptomaine poisoning. For two days they treated the sick men by wireless and finally received this message from the freighter:

"Your directions followed. All but six now on duty. They are recovering fast. Thanks and God bless you. *Bon voyage.*"

On the heels of this message came another from a second freighter stating that a member of her crew was in agony. The doctors had only a layman's diagnosis on which to base their treatment, but they sent back instructions. The following morning they were surprised to receive a message from an Italian steamer three hundred miles in another direction. It read:

"Many thanks to the S. S. *America*. We had a sick member of crew suffering from similar ailment. Prescribed same as directed for other steamer. Our patient recovering. God bless you."

The operator of the S. S. *Ryndam* received a message one night which caused him to hurry to the quarters of Dr. William Ford. The message came from a freighter, and read:

"Captain's wife on board. Expects arrival of stork before we can reach port. Please assist."

The *Ryndam* was too far off to race with the stork, but Dr. Ford gave the operator directions which he thought a layman could follow. Two days later this news came.

"Now have a new son. Don't know your name, doctor, but will call him Napoleon. A thousand thanks and God bless you."

It remained for the Seamen's Church Institute of New York City to establish a radio medical service for ships at sea. About a year ago the Institute realized the need for medical service on board ships that do not carry a physician and decided upon giving such service by radio. The matter was taken up with the Department of Commerce, which granted a special commercial license and the call letters KDKF. Ever since last April this station has been in operation. When a radiogram asking for medical assistance has been received, it has at once been telephoned to the Hudson Street Hospital in New York City. A physician there has telephoned back the necessary medical information, which has been sent by radio to the ship at sea. Great care has been exercised in order that the physician's precise instructions would be accurately transmitted. Indeed, the physician's instructions are received on a dictaphone by means of a special amplifier, which saves the physician from repeating them.

So valuable has been the medical service of the Seaman's Church Institute that the United States Public Health Service has undertaken to make the work national instead of purely local in scope. The Government has taken charge of this unique marine medical agency and is now coöperating with the Institute and with the Radio Corporation of America. The latter organization is going to coöperate with the Institute and the United States Public Health Service in the handling of free medical advice to ships at sea, through its stations at Chatham, Mass.; Siasconset, Mass.; Bush Terminal, Brooklyn, N. Y.; Cape May, N. J.; San Francisco, Calif. Hospitals designated to furnish information are: United States Marine Hospital, New York; alternates, Hospitals 38, 43, 61. United States Veterans' Hospital 49, Philadelphia; alternates, United States Veterans' Hospital 56, Fort McHenry, Baltimore, Md. United States Marine Hospital 19, San Francisco; alternate, United States Veterans' Hospital, Palo Alto, Calif.

RADIO FOR LIFEBOATS

HOW can radio telephone apparatus, for sending as well as receiving, be installed in a lifeboat?

The proper navigation of such a boat in a storm makes it necessary to reduce to a minimum any apparatus above the deck level. No loose wires above, in, or under the boat are permissible, since this would interfere with the proper handling of the boat and the throwing of lines. A small antenna of the ordinary elevated type would be highly undesirable from the navigating point of view.

Those were the obstacles that arose when the United States Coast Guard and officials of the Bureau of Standards considered the application of radio telephony to the problem of communication between a shore station and the life boat tossing out in the open sea. The importance of communication was obvious. It was attacked diligently, and after tests it is believed that the question has been answered.

The boat selected for the test was a thirty-six foot, motor driven lifeboat, equipped with a heavy metal keel. The receiving and transmitting set was installed as far forward as possible. From the set a wire was run forward and connected to the metal keel. Two more wires, heavily insulated, were run aft from the set along the guards and connected with the keel. A particular kind of coil antenna was thus formed, of which the keel constituted a part. This arrangement was satisfactory from a navigating point of view.

The transmitting apparatus used at the shore station and on the boat were identical, and consisted of a five-watt radio telephone transmitting set. The wave length used for

RADIO ON A LIFE BOAT

The receiving and sending set installed well forward

THE LIFE BOAT AERIAL.

Showing how the wires were arranged on the boat to form a kind of coil antenna

transmission from the boat was 380 metres; the shore station used a 675-metre wave length. The receiving equipment included an amplifier, using three stages of radio-frequency amplification, and two stages of audio frequency amplification, and was specially designed for the wave length used. The apparatus on the boat was particularly compact.

A demonstration was given at Atlantic City. When the boat was six miles from shore, good communication was maintained with the shore station. This distance is considered sufficient for the ordinary needs of the Coast Guard. The test was regarded as very satisfactory, and as a result the Coast Guard is considering the installation of radio telephone equipment at a number of the more important stations.

A TROPICAL ISLAND RADIOPHONE

Radio Adventures Among the Bahama Islands

By CHARLES T. WHITEFIELD

LIKE most "fans," we hated to abandon our radio receiving telephone when we left home for some mild adventures among the Bahamas. So we packed it up with the idea that we could install it on the good ship *The Sea Scamp* a schooner of 70 feet which we had sent on to Nassau, New Providence, from Miami, where she had spent a comfortable summer getting a new coat of paint and all the troublesome expensive things that yachts require.

On the good ship *Munargo* coming south we had snatches of W J Z, Newark, but the air was jammed with local messages in short waves, and especially troublesome was the radio hog who amused himself by printing his alphabet, calling aloud to Heaven to hear his efforts, and completely blinding much better material.

When one leaves cold weather and New York, one's head is stuffed with plans of things to do among the Isles of June; but warm weather is very quieting to the ambitions of even the most energetic, and it seemed a big job to rig up the wires on the schooner; so we postponed this task until later.

Now along came Dan Smith, a full fledged radio bug. Radio was the very breath of his nostrils, and his conversation was so full of strange technical words that one felt instantly that here, indeed, was a man who could reach out into the ether and take from it what he willed. Newark, Washington, Pittsburgh, which had seemed to us so far away, he said would "come roaring in" if we gave them a chance, and, besides, he would do all the work.

Nassau, the metropolis of the Bahama Islands, is crowned by a hill, and on the top of it lives a very kind friend to whom we had talked much of radio, somewhat to his incredulity. Here was the ideal place to string the wires to Heaven, and the regulation that any one operating radio in these Islands must pay a fee of 5 shillings a year did not seem an insurmountable objection.

The idea that one could listen in Nassau to a concert being performed in Newark, N. J., and East Pittsburgh, Pa., seemed to our friends what they called a quaint piece of imagination. However, they put the island carpenters at work, and in a few hours the enterprising Dan Smith had the wires stretching over the roof of Government House.

In the daytime in Nassau one can do little with radio—the static is so bad—but the work was finished by evening and our friends sat about curious to see if this box of magic would do anything wonderful.

The final wires were connected—the anxious moment had arrived—and produced—not a sound. A heart-breaking pause. Perhaps the wires were on the wrong poles of the battery. They were. A violent hum developed, and in a minute a clear voice was heard talking at Miami, and then Newark and Pittsburgh. Our Nassau friends were now convinced that we were not liars, and so began our experiments in the Bahama Islands.

The natives here are soft-spoken, well ordered black people with some ambition and real charm. One quality which very much amused us in the Out Island was their implicit

THE "SEA SCAMP"
which carried the idea of listening in to the Bahamas

faith in everything you could tell 'em. We thought they might shy at a tale of what radio telephony could do, but all our stories were accepted at par. Had they not heard the words of living men and music come out of the black box wound up with the crank; had they not seen in the Sunday School building, men and women walking as shadows on the white wall? If this white stranger from the great world says he can pick out from the sky music, words, and the sound of the fiddle or the banjo, we know he can do it, and we ask him to put up the strings which connect with the sky and we will all keep quite still and listen.

All that the white man said came true, as they knew it would.

Of all our friends at Dunmore Town (on Harbour Island), none knew of the radio telephone. The mysterious machine which made dots and dashes, that but one man in the place understood, had no appliance for hearing the news and music in the ether by wireless telephone. The promise of bringing to earth opera singers from New York and Pittsburgh was much appreciated, as a child shows its pleasure for what it does not understand, but accepts as from the fairies. I am sure that all the natives would answer to Barrie's "Do you believe in fairies?" a positive yes. Governor's Harbour, where they also have a more or less mute radio, is one of the other of the two or three places in all these islands that have even the beginnings of radio contact with the outer world. After leaving these centres of population, you find only little settlements of from 100 to as few as 10 inhabitants. At Watling Island, 300 miles south of Nassau, the first land Columbus touched, a Commissioner and a handful of natives make up the entire population—not even a school was here. But Watling Island light is important for the ships trading to Cuba and the West Indies, and here two lonely men live out a monotonous existence in a blistering sun the year round. Signing the visitors' book, we found that the last visitor had arrived involuntarily about two years before and his ship had been lost.

Another lighthouse not so far away has communication with the outer world only once every two months. One longed to give to each of these self-effacing but necessary workers the receiver off the boat and provide for them a touch with all mankind during their lonely vigils, four hours off, four hours on, never a full night's sleep.

At Bimini, the radio will soon take the place of the old Bahama "Welcome Tree."

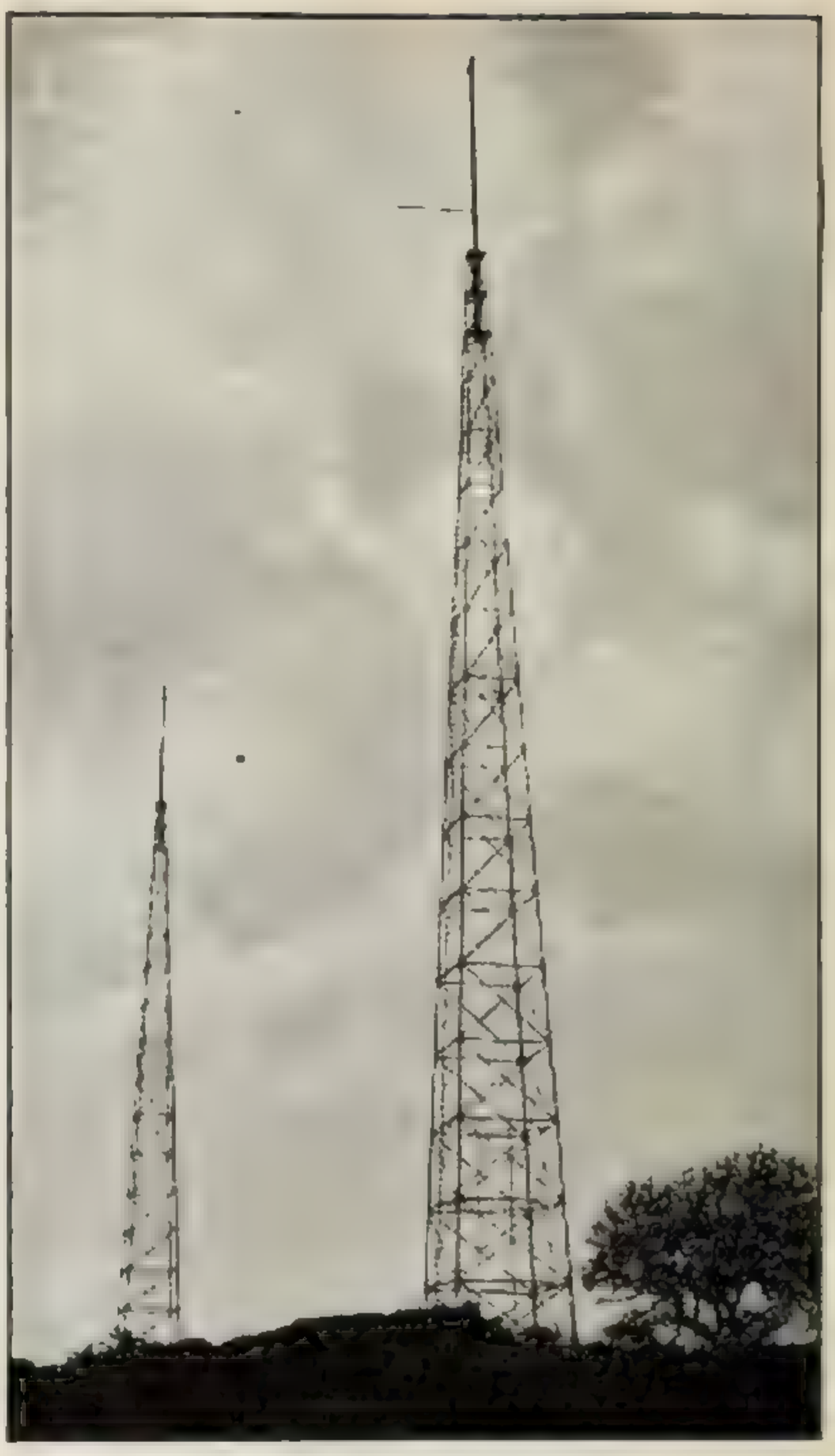
COMING ABOARD TO HEAR THE RADIO
The *Sea Scamp* being visited by the police force of Harbour Island, the Bahamas

Bimini is now the famous "Booze Port." I well remember landing in the primitive days of 1917. Few yachts stopped at the Biminis, and it was a great day when a stranger came. The whole village (about twenty people) squatted under the "Welcome Tree" and the news of the world outside was revealed to the natives. Where this kindly "Welcome Tree" was, now is a huge club-house dedicated to rum in its various forms.

No more delightful experience could be found than introducing the radio telephone to these simple people. One evening we had a crowd listening to W J Z, the aerial being run from a flagstaff put up at almost a minute's notice. When we told them that W J Z meant Newark, N. J., they accepted it with entire trustfulness. If we had said that the people they heard talking and singing were in the moon, I have no doubt that that, too, would have been accepted.

One thinks of the tropical islands of the world as delightful places where the weather is always fine, food easy to come by, as it grows without attention, and occupied by a people of contented minds enjoying an easy life.

The real thing is quite different. These islands of the Atlantic, as well as the Pacific, are often stormbound for weeks- and travelling in small boats, the only means available, is uncomfortable and dangerous. The number



THE RADIO STATION AT NASSAU
Not equipped for radio telephone broadcasting which is practically unknown in the Bahamas

LISTENING TO AMERICAN MUSIC
On board the *Sea Nymph* in Harbour Island, the Bahamas

of lives lost among these island people is by no means small. Money, clothes, and food are for the most part scarce; and, almost worse than all, the pleasures of life, the occupations after the day's work is finished, are few and far between. To such people a simple and cheap radio telephone will revolutionize their life. From Nassau, where they have a good radio plant, they could broadcast to a thousand islands, giving not only amusement, but information of the utmost value, including, most important of all, storm signals which might easily save hundreds of lives.

To such a region as this—lonely, starved for a touch of the pulsing life of the great world—radio will come as more than a convenience or another form of pleasure. To the people here it will be literally a godsend.

THE ARMSTRONG PATENT

How an Undergraduate at Columbia University Discovered One of the Most Important Instrumentalities in the Radio World

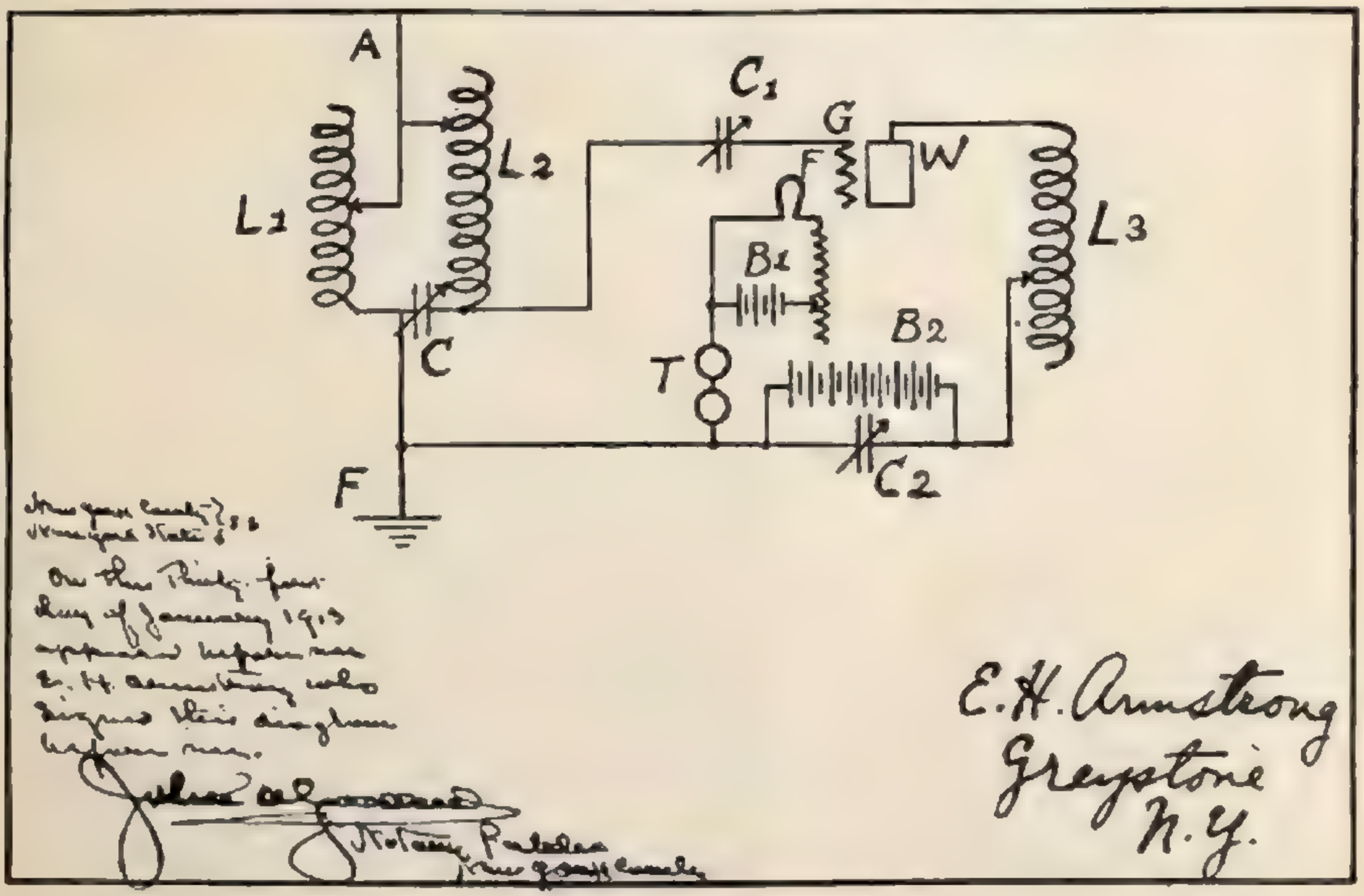
MR. EDWIN H. ARMSTRONG has been confirmed by the United States District Court of Appeals as the inventor of an instrumentality which has been referred to as "one of the most important inventions, if not the most important, in the wireless art." By a striking coincidence the decision comes in the midst of the development of a great public interest in a service made possible by the invention.

Mr. Armstrong is a young man and was a student at Columbia while he was perfecting his revolutionary method. The instrumentality is the Armstrong feed-back circuit, the invention which makes possible the amplification of incoming radio waves, and lacking which neither long distance radio telephone communication nor radio telephone broadcasting would be possible.

The Court of Appeals thus upholds the decision handed down a year ago by Federal Judge Julius Mayer in the long fight between young Armstrong and Dr. Lee de Forest and the De Forest Radio Telephone and Telegraph Company. The decision of the court, which is final, means that no long distance telephone communication, no nightly broadcasting programme can be carried out without using the Armstrong patent. Even the modern multiplex forms of wired telegraphy and telephony must use the methods.

The story of Armstrong's struggle for recognition has well been called one of the most romantic incidents of scientific achievement. He began his experiments with radio as a boy of fifteen. Before and during his student days at Columbia he became a close student of the fundamental action of the audion and read all the literature available on the subject.

THE ORIGINAL DRAWING OF THE FEED-BACK CIRCUIT WHICH LARGELY DETERMINED THE COURT IN ARMSTRONG'S FAVOR



Armstrong's original drawing of his feedback circuit, submitted to the U.S. Patent Office by leaping from New York City, Feb 1, 1914

Sometime during this period he connected a condenser across the telephone of a simple audion receiving system and noticed that on some bulbs an increase in signal strength would result.

He proceeded with his careful studies and experiments and obtained what he believed to be remarkable results. He showed the results to his father and asked for money with which to make application for a patent. His father refused, apparently not greatly impressed. Armstrong then applied to his uncle who also declined to finance him but suggested that the young man make a drawing of his principle and have it witnessed by a notary. Armstrong did so and it proved to be the most significant event of his life. The decision of the court was very materially influenced, it is apparent, by the fact that Armstrong had definite theories and beliefs about his invention and had carefully recorded them.

Armstrong failed to get the support of his family, but he did gain the attention of Professor Michael I. Pupin who took him into the Marcellus Hartley laboratories at Columbia University and enabled him to continue his researches. Litigation began in 1916 and continued until this country entered the war when a truce was signed. Armstrong was commissioned a major in the Signal Corps and was sitting in Hindenburg's former headquarters at Spa, Belgium, after the Armistice when a cablegram from his lawyer announced that Doctor de Forest was again pressing for action. The end has now been reached.

In the meanwhile Armstrong had issued licenses for the use of his patent in manufacturing receiving sets to seventeen different concerns, and then sold the patent itself to the Westinghouse Company. Under the licensing agreement which the Westinghouse Company has with the other manufacturers which sell through the Radio Corporation, the Armstrong circuit will continue to be used by them. The decision will not affect these manufacturers nor the public. It will give credit and profit where both are due.

E. H. ARMSTRONG

The discoverer of the "feed-back" circuit, in the uniform of a major in the Signal Corps during the war

ADVENTURES IN RADIO

Perhaps no other branch of science enjoys the romance and the spirit of adventure ever present in Radio. It matters not whether it is the radio telegraph or the radio telephone, one has as many advantages as the other in this respect. Of course, radio telegraphy is the older of the two, and its exploits are more numerous; up to now, it covers a wider field of endeavor on both land and sea.

Aside from the everyday uses of radio, there are a great many instances in the history of the art which stand out as milestones in the march of progress; instances which few devotees of radio broadcasting know about. Many of these adventures were unique—not always possible or practicable to duplicate; on the other hand some were accidents, others mere incidents, still others great adventures; adventures never to be forgotten and which stand out as red letter days for the individuals concerned.

By adventures of radio we mean that which deviates radically from the commonplace. Radio has

been responsible for many innovations—many new uses, some of which passed out of human ken, others were repeated again and again until to-day we have ceased to wonder and be thrilled when we chance to read newspaper accounts of such doings. Thus, we have the Radio Reporter, the first authentic, instances being that of reporter Sprague of the Los Angeles Examiner *who, pressed for time and an urgent desire to "scoop" the other sheets, commandeered the radio telephone set of a local army officer in order to report an unusual sporting event. Then there is the Radio Detective who came into his own during the war and of whom more will be said in a future number. The Radio Doctor has again and again proved his worth at sea and many a sailor owes his life to a medical consultation held by radio from ship to ship or from ship to land. The initial success of the Radio Actor, or Actors, who have broadcasted an entire play over the radio telephone still rings in our ears. Then we have radio as the leading factor in the lives of the gunrunner, the smuggler, the arch criminal, the Central American revolutionist, the international spy, the cast-away sailor, and so we might go on indefinitely, for the exploits of radio are legion; some of which stand out as monuments of scientific achievements; others are ignominious ones to which this noble art has been unwillingly subjected. All of these nevertheless are intensely interesting, breathing of the very spirit of adventure and romance.*

To this end, it will be the purpose of this department to report each month, radio adventures that actually took place, with real human beings as principals. The series will range over the entire world with incidents taking place in Sweden, Patagonia, and far-off Japan, as well as in the United States.

The editors would be glad to receive accounts of such radio adventures from readers of the magazine, either their own experiences in the first person or authentic experiences of others.

FOUND BY RADIO

By PIERRE BOUCHERON

ONE of the most romantic stories of the power of radio is the story of the finding of Cleo Archer. In January, 1920, Lester Archer was a young radio amateur living in Toledo, Ohio. This was before the day of widespread radio telephone broadcasting. With his radio set using the Continental Morse Code this young man accomplished in a short time what his mother, lawyer, and private detective agencies had been trying to do for thirteen years. At the age of five, Cleo Archer, Lester's sister, had been secretly placed in the Allen County Children's Home of Ohio by unfriendly relatives. To find Cleo became the life aim of young Archer and his mother, Mrs. Dorothy Archer, and to this end, they visited other cities and towns in a vain search, meanwhile conducting a legal battle to compel the home authorities to divulge Cleo's whereabouts.

In 1910, this young man, then but a boy in knee pants, became interested in amateur radio, and in a short time he had done what many thousand boys have since duplicated; erected a complete sending and receiving station enabling him to converse at ease with local enthusiasts. For the next few years he spent a great deal of his spare time experimenting and improving his installation so that he was able in 1920 to send as far as 1,000 miles with his home-made transmitter, as well as to receive from the long distance high power stations at Nauen, Germany; Stavanger, Norway, and Lyons, France.

In talking, or rather telegraphing, through the ether, Archer's radio acquaintances reached considerable proportions, until they included many amateurs from neighboring states. The greater portion, of course, he had never seen, but they nevertheless all belonged to the great fraternity of the ether. One of these radio friends was Mrs. Charles Candler, of St. Marys, Ohio, who, with her husband, operates the powerful amateur station "8ZL" now well known throughout the United States for its long distance records.

One evening of January, 1920, young Archer was "talking" with Mrs. Candler in the comradery which radio boasts as its very own, when he conceived the idea of asking for her coöperation in broadcasting the "call" for his sister, Cleo. With the aid of the multitude of amateurs within the reach of "8ZL," Mrs.

Candler thereupon offered to transmit a general message bearing the girl's description and asking for information regarding her whereabouts. The first radiogram of this nature was sent late in January and was, of course, picked up and relayed by hundreds of other amateurs throughout the country who were only too willing to help in the search. Archer, meanwhile, sat night after night at his receiving set listening for a possible encouraging reply. Weeks passed and it began to look like a hopeless task when one evening, the faint call "8KV" (Archer's registered call signal) came from another amateur located at Van Wert, Ohio. Following this call, came some words hardly discernible, so faint were they, and in which young Archer was able to distinguish the words "your sister." Late at night of the same day, when most amateurs had closed for the night and local interference had subsided, Archer was again able to establish communication with the Van Wert station and was informed that a young girl answering the radioed description of his sister was living at the home of a near-by farmer at Rockford, Mercer County, Ohio. Moreover, this amateur flashed back that he had been trying to reach Archer for the past two weeks but without success, owing to the limited range of his sending equipment.

Needless to add, it did not take long for Archer and his mother to investigate the radioed report. Much to their surprise and joy, the report proved correct and the girl was recognized instantly as the long lost one.

The story of Archer and his unique use of the ether is indeed an achievement to amateur radio of this country. To-day, with our great and far reaching radio telephone broadcasting stations throughout the country, we have at our disposal, probably, the most effective and inexpensive means of locating absent ones yet devised, and as the fame and worth of radio spreads far and wide it is quite reasonable to expect police officials to resort to its use for a multitude of purposes, whether for seeking the whereabouts of lost ones or for hunting criminals.

In the next number of the magazine this department will tell some adventures of radio in the police departments of our large cities, describing some actual instances which have occurred up to date and probable ones of the future.

THE GRID

Questions and Answers

The Grid is a Question and Answer Department maintained especially for the radio amateurs. Full answers will be given wherever possible. In answering questions those of a like nature will be grouped together and answered by one article. Every effort will be made to keep the answers simple and direct, yet fully self-explanatory. Questions should be addressed to Editor, "The Grid," Radio Broadcast, Garden City, N. Y. The letter containing the questions should have the full name and address of the writer and also his station call letter, if he has one. The questions and answers appearing in this issue are chosen from among many asked the editor in other capacities.

What is a loop antenna?

Will a coil antenna work if it is inside a house?

How does a radio compass work?

How many turns should be in a loop antenna to receive from a broadcasting station on 360 meters?

Loop or Coil Antenna

THE names loop antenna and coil antenna are used to designate the same kind of an antenna. This antenna is mainly used in the reception of radio waves. It consists of a boxlike frame upon which is wound turns of wire. The frames may be of different sizes, but the usual sizes are 4, 6, or 8 feet square. They should be made so that they can be rotated around an axis, such as $X-X^1$ in figures 1, 2 and 3. (See page 78). Figures 1 and 2 show two different ways of winding the wire on the frame. In Figure 1 the wire has been wound on the outside of the frame. In Figure 2, the wire has been wound on the frame. Thus the wire lies in the same vertical plane. The distance between the turns of wire is called the spacing. This is represented at *a* in Figure 1. Figure 3 shows a good method of constructing the frame work for a loop antenna. The diagonal pieces aa^1 and bb^1 should be made wide enough at the ends to permit the proper spacing

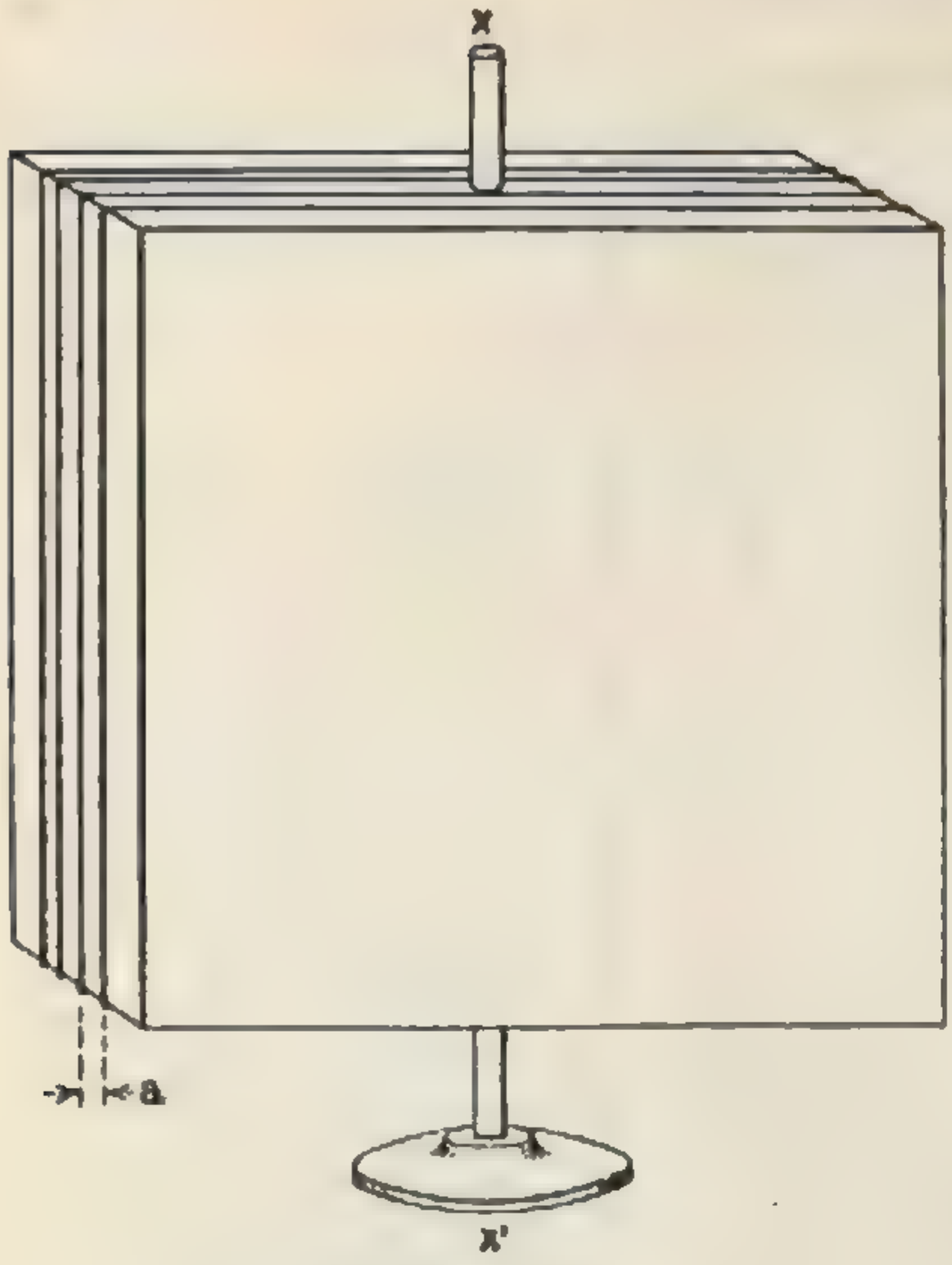


FIG. 1

of the wire. The figures are not drawn to scale so that they cannot be used as working drawings. Figure 2 for instance shows turns of wire near the centre of the frame. In reality the turns of wire are placed toward the outer edge of the frame. In general it will be found that a coil antenna such as shown in Figure 1 is the most satisfactory kind to use. In constructing the antenna, as little metal, as possible, should be used.

The antenna may be hooked up to the receiving set in a number of different ways. If it is desired to use a "tuner," the ends of the wire may be connected directly to the terminals to which the ground and the antenna lead-in wire would be connected if an ordinary type of antenna were used. This hook-up is shown in Figure 4. PC and P1 represent the primary

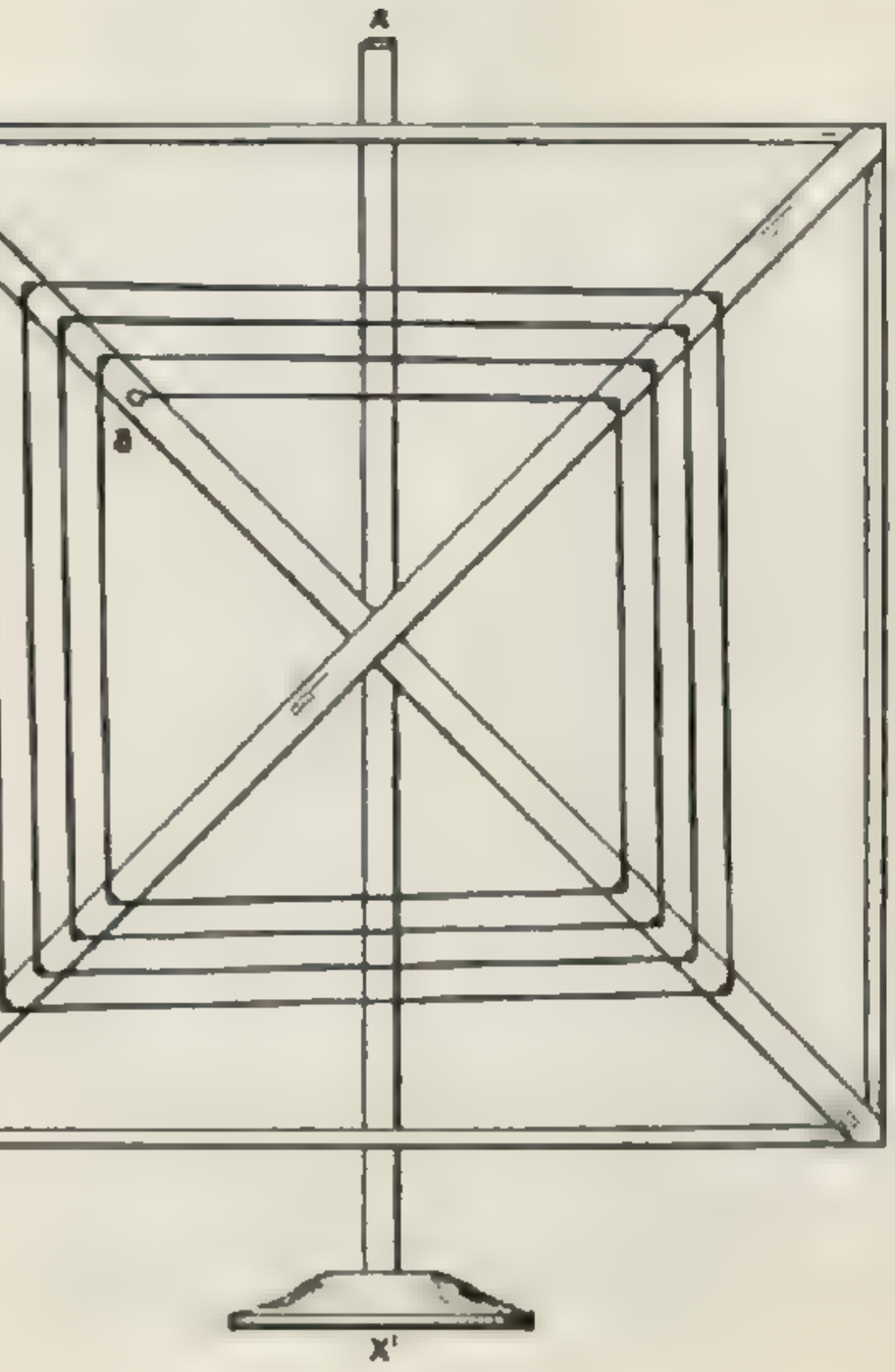


FIG. 2

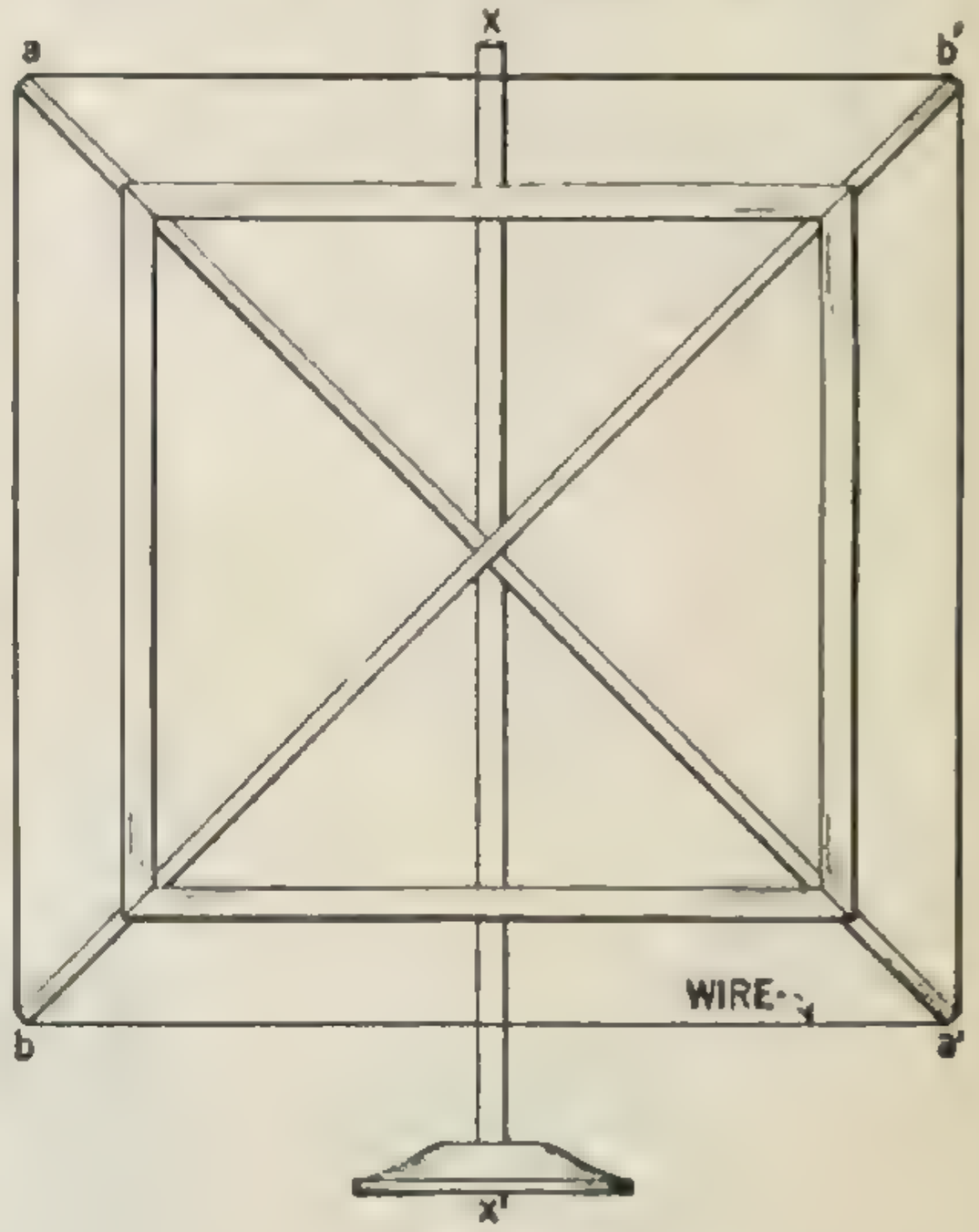


FIG. 3

condenser and inductance of the tuner, and SC and S1 represent the secondary condenser and inductance. L represents the coil antenna. It is to be noted that no ground connection is necessary.

Although a tuner may be used, none is necessary, for the selectivity is sufficiently sharp to cut out all ordinary interference. The method of connection in this case is shown in Figure 5. There is a variable condenser shunted across the loop and leads from each side of this condenser go to the detector. No inductance is needed, as this is furnished by the loop. Again no ground connection is made. This method of connection allows much fainter signals to be

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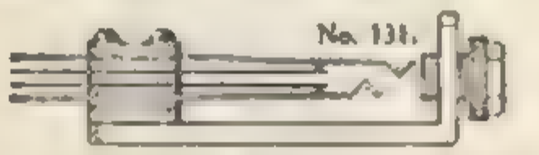

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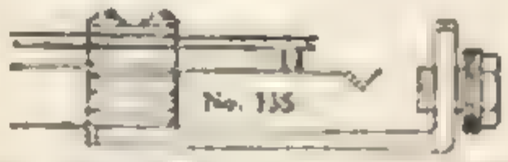

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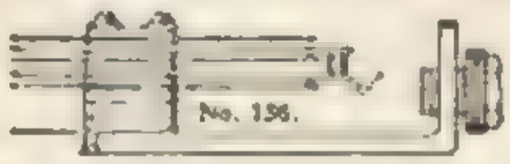

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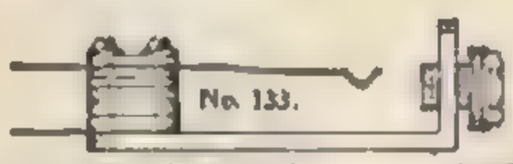
No. 163—3000 ohm.. 6.00
Undoubtedly the best phone on the market for the amateur's use. Approved by our Engineers.



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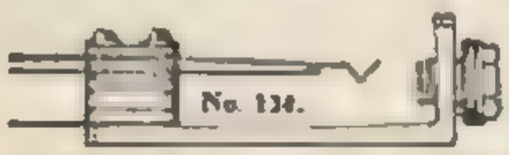

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picked up than the first method. This is because the energy lost in the tuner in the first method is saved by the second method. One advantage of the first method, however, lies in the fact that, with the same capacity, a greater range of wave lengths can be received than by the second method.

The following data concerning coil antenna is given as a guide for making one. This data does not follow, in some respects, the formulæ that have been developed by radio engineers for the design of these antennæ. However,

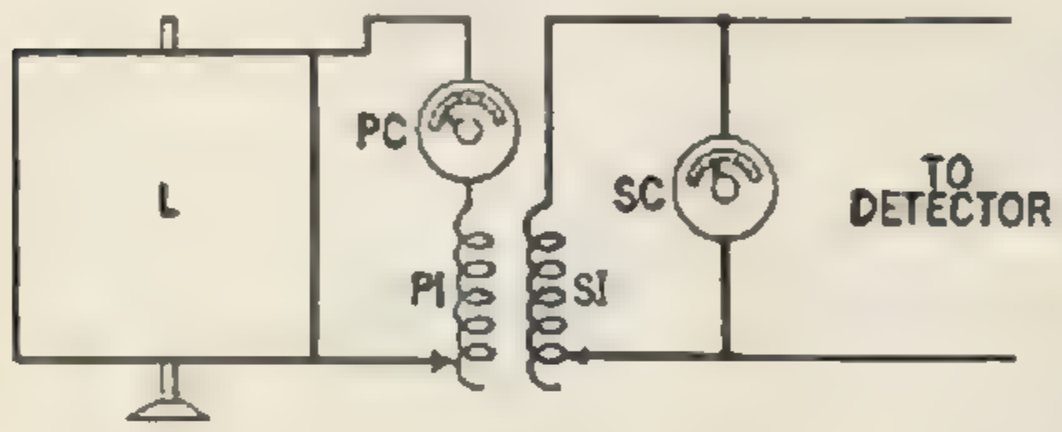

FIG. 4

coil antennæ made according to these descriptions have given good results.

To receive 360 meters. Coil made as in Figure 1. Frame four feet square. Ten turns of wire. Spacing 3 inches. Tuner to be shunted across the coil as shown in Figure 4.

To receive 600 meters. Coil made as in Figure 1. Frame four feet square. Ten turns of wire. Spacing one-fifth of an inch. Condenser only to be shunted across coil as in Figure 5.

To receive 3,000 meters. Coil made as in Figure 1. Frame six feet square. Fifty turns of wire. Spacing seven-sixteenths of an inch. Condenser to be shunted across the coil as in Figure 5.

These examples ought to enable one to make a coil antenna with some assurance of success. The following simple rules apply:

A longer wave length requires more turns if the size of loop and spacing is unchanged. Conversely shorter wave lengths require fewer turns.

For the same wave length and spacing, increasing the size of the loop diminishes the number of turns required. The converse of this is true.

For the same wave length and dimension of coil, decreasing the spacing decreases the number of turns required. This factor makes a very considerable difference in the number of turns. The converse of this is true.

Ordinary No. 18 bell wire is a satisfactory wire to use.

RADIO COMPASS

A RADIO wave consists of electromagnetic and electrostatic lines of force. These sweep the coil antenna and affect it. Considering only the electrostatic lines of force, it is seen that their effect upon the coil is as follows: (The effect of the electromagnetic lines of force is the same, as can be shown by a different process of reasoning). At any given instant the electrostatic lines of force have *different* intensities at *different* distances from the source of the waves. Also at any given instant the electrostatic lines of force have the same intensity at the *same* distance from the source of the waves. Electrostatic lines of force set up potentials in an object which they sweep. If in the same conductor one part is at one potential and another part at a different potential, a current will flow. Suppose the coil antenna is directed toward the sending station. One end of it is nearer that station than the other end. Hence the two ends are at different distances from the sending station, at any instant the two ends are swept by electrostatic lines of force of different intensity, which consequently sets up a different potential in the two ends of the coil. This difference of potential will cause a current to flow, thus enabling the signal to be heard. On the other

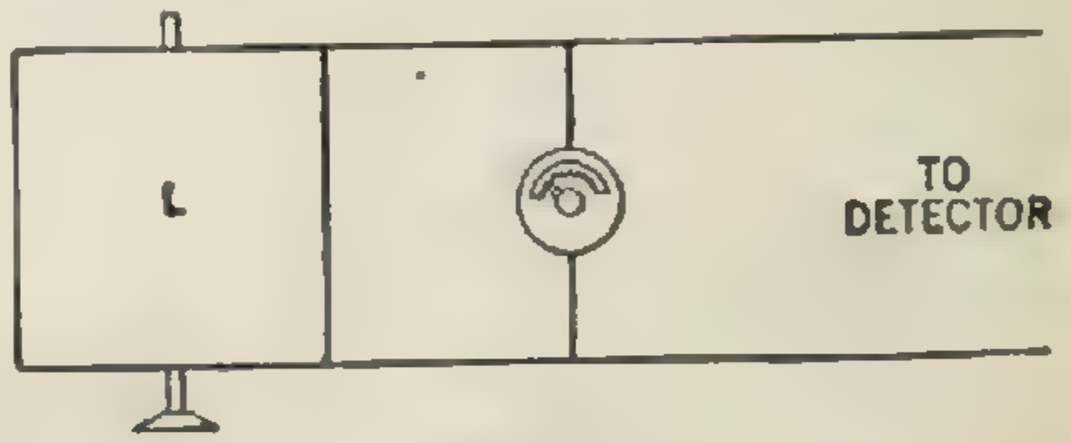

FIG. 5

hand if the coil is broad side to the sending station, the two ends are equidistant from it; they will be swept by electrostatic lines of force of the same intensity; there will be no difference of potential established; no current will flow and no signal will be heard.

Thus it is seen that when the coil is directed toward the sending station, full strength signals will be heard and when it is at right angles (broadside) to the sending station no signals will be heard. At intermediate positions the strength of the signals will vary from zero to

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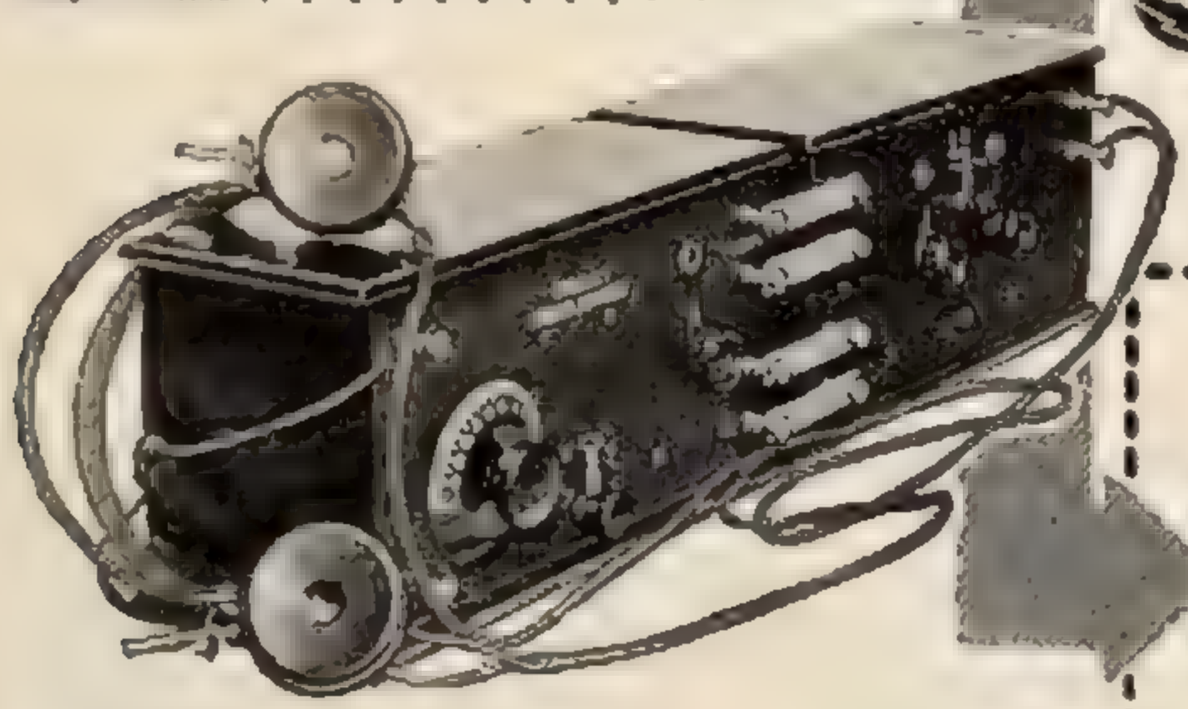

See this complete outfit at any dealers or send us this coupon for catalogue and we'll see that your dealer has one in a few days.

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RADIO DEP'T
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CROSLEY MFG. CO., Radio Dept.

Gentlemen: RB-1

Send me your Radio apparatus catalogue and full details of outfit featured here.

Name _____

Address _____

The dealer I should like to see handle your products

is _____

full strength. It is the facts just stated that make a coil antenna a radio compass.

The method of using a coil antenna to determine direction is best described by an example. A coil antenna is set up free to rotate. It carries a pointer which passes over a circle graduated in degrees; the zero point of the circle being to the north. A signal is picked up after proper tuning. The coil is rotated until the signal is just about to become too faint to hear. The position of the pointer is then read. Say this is 164 degrees. The coil is again rotated in the same direction until the signal reappears with the same intensity at which the first reading is taken. Another reading is taken. Say this is 196 degrees. The average of these two readings $\frac{164 + 196}{2}$ gives you the position at which the coil is broadside to the station. In this case it is 180 degrees. This is the north and south line as 0 is at the north. The transmitting station then is at right angles to this direction. The transmitting station of the example lies in an east and west line. Whether it is east or west of the coil can not be told by any simple radio method, but this general direction is usually known.

For greater accuracy, four readings should be made and their average taken. The third and fourth readings are approximately 180 degrees from the first and second reading and are obtained by continuing to turn the coil around. However, unless the coil has been specially designed for a radio compass, it is not worth while taking these extra readings as the first two will give as great an accuracy as the coil will allow. The cause of inaccuracy of an ordinary designed coil will not be discussed in this article.

A coil may be mounted inside a room and will receive signals as well as if mounted outside unless the room has a great deal of metal in it. However, if a coil is used as a compass inside a room, there is likely to be an error due to that fact. Thus a radiator in the room will pick up the radio waves and re-radiate them, thus becoming a secondary source of waves. This will affect the loop, causing it to show a direction wrong by as much as 10 degrees in some cases.

It has been found that coil antenna diminish the interference due to static. This is a great advantage in their use. In general, the smaller the loop, the more the static is diminished. Another advantage lies in the fact that, because of their directional characteristics they eliminate many interfering stations. Other advantages lie in their compactness and ease of construction. In conclusion, it is desired to point out that for any given condition, such as wave length and kind of apparatus to be used with it, there is a certain sized, spaced, etc., loop that will give better results than any other loop. With this article for a guide a few trials ought to produce this one best loop for you.

MERCHANDISING RADIO

A Discussion of Some Interesting Points for the Retail Store to Stimulate Sales

By A. HENRY

TO-DAY we find radio apparatus upon the counters of the hardware store and even the corner drug store, but we wonder whether or not this condition will continue after the present rush for radio apparatus has subsided and the steady, normal demand for equipment again prevails. Many authorities on radio merchandising agree that the present demand will, in all likelihood, be supplied within the next few months, and that preparations for supplying an even greater volume of business next year are to be arranged during this summer.

There are two distinct classes of radio dealers, but only one is to be a permanent feature in this merchandising field. First is the dealer who knows nothing whatever about radio other than that it is a very popular pastime and it offers him an opportunity to make a rapid turnover. The other and more stable radio dealer is the man who understands the radio business thoroughly and is not satisfied to limit his

efforts to the mere making of sales to-day with no thought of the days to follow.

In order to make certain of a permanent standing in the radio business, it is necessary for the dealer to be able to discuss amateur radio conditions with his customers. He must understand their likes and dislikes and cater to them. There are many ways in which this may be accomplished, not the least of which is joining a local radio club.

THE MODERN WAY OF SELLING RADIO APPARATUS
A club-room fitted with radio equipment in the rear of a dealer's store

A dealer should not only join a radio club, but he should be an active member. At the club meetings it is possible for him to be of great assistance by loaning apparatus for use in illustrating timely lectures. There is probably no better form of publicity than an illustrated lecture demonstrating the use of equipment which may be secured at the local dealer's.

SELLING UNITS

THE dealer may stimulate his sales very materially by having complete transmitting and receiving sets made from stock parts, completely wired on a single board conspicuously displayed on his counter or in the show-case. An arrangement of this character is shown in one of the accompanying illustrations, and it has been very effectively employed by one of the largest radio retail stores in the country. It is made up of stock parts and wired so that the experimenter coming into the store may have a striking picture of just where and how each unit is employed in the circuit.

LISTS OF PARTS

IN ADDITION to the display of a component part assembly, the dealer will find it advantageous to prepare a list of the elements included in the circuit. This list should also include such items as may be interchangeable and are carried in stock by him. For instance, under the heading of condensers or inductances, the dealer may handle several, designed to accomplish the same purpose; where this is so his list should include all of them.

In building sets of this character, the dealer should provide two or three standard transmitting and receiving circuits, increasing this number when some new and particularly advantageous arrangement or instrument has been developed.

A CLUB ROOM FOR CUSTOMERS

WHERE space permits, the establishment of a club room for the use of customers is a highly desirable feature in a retail store. This is especially true in the business sections of large cities because it permits prominent radio amateur and professional men to get together for a short time during their lunch hour. One dealer has increased his business more than 500 per cent. in five months after the establish-

The CAPITAL Serves Indiana, Ohio and Kentucky

Interior of Salesroom

THE Capital Radio Supply Company, located at Indianapolis, was organized by prominent business men for the purpose of supplying this territory with the finest, most dependable and efficient radio equipment made.

Among the prominent manufacturers who are represented by this company are Grebe, Kennedy, Remler, King Ampli-tone, Hipco Batteries, Western Electric, Signal and Tuska.

Because of the financial strength, the experience and efficiency of the organization and the geographical location, the Capital Radio Supply Company is logically the distributor to *successfully* handle this rich territory.

CAPITAL RADIO SUPPLY COMPANY, Inc

Indianapolis, U. S. A.

ment of such a club room. The first room of this character was undoubtedly employed by a radio company in New Orleans several years ago, and its growing popularity proves that stimulation of sales has always resulted from its adoption.

Suitable transmitting and receiving apparatus should be permanently set up in the club room, a table and a number of chairs should be provided, as well as a fairly large blackboard. Patrons should be permitted to borrow equipment from stock for the purpose of making special tests or demonstrations. Wherever possible, sales folk should take an active interest in fostering this club room, helping to make prominent amateurs known to each other and settling some of the technical discussions which are bound to arise.

APPARATUS IN OPERATION

REGARDLESS of whether or not a club room is provided, the live radio dealer should not overlook the opportunity of installing a complete receiving outfit with a "loud speaker" in his store. There are so many broadcasting stations located throughout the country that but very few dealers will find it impossible to have such a receiving outfit provide the best kind of publicity for them. A "loud speaker" in operation is always an attraction, not only to radio folk but to the passer-by. The receiving equipment should be accompanied by a number of descriptive placards suitably located, telling briefly the how's and why's of radio broadcasting.

In addition to this form of receiver it is sometimes found advisable to employ several complete demonstration outfits varying in price from the cheapest to the best, which may be connected or disconnected at will.

In this connection the dealer should be extremely careful to provide demonstration outfits only when they are found to operate satisfactorily, because a poor demonstration is a boomerang.

KEEPING PACE WITH THE FANS

A MODERN transmitting station should be installed in the dealer's home as well as his store, and he should avail himself of every opportunity to carry on communication with his customers. We have pre-supposed that the dealer understands radio. This is certainly the most satisfactory basis for the carrying on of a radio store, but where the dealer himself is not intimately familiar with radio he should at least have in his employ men who are.

The value of keeping in touch with the radio fans in a dealer's territory is very completely demonstrated by the fact that a certain Southern dealer controls practically all the radio business in his city because he and every clerk in his store are expert radio men whose interest in the business does not cease with the closing of the store. They are actively engaged in amateur work and are known, if not personally, at least by radio acquaintance to a very great number of radio enthusiasts. This intimacy has resulted in amassing a business which was formerly controlled by a competitor who had little knowledge of radio, other than that there was a demand for the apparatus and it was possible for him to obtain a profit from its sale.

Radio has expanded so rapidly that there is now plenty of room for a vast number of retail dealers. However, when the stable business which is surely coming has arrived, the only dealers who will survive are those who have rendered service and satisfaction to their customers. To-day this is not so, for the demand is so great that consumers are almost forced to buy wherever equipment may be procured, but to-morrow is another day even though it does not dawn for several months.

AT THE PRESENT TIME

IN THE present emergency even the more forehanded dealers are out of stock of various parts. It is extremely short sighted, therefore, for the dealer to take advantage of a competitor because he happens to be in a position to do so by good luck rather than good management. By this is meant that reflections upon a competitive dealer on lack of stock should not be passed along to customers. Unfortunately, circumstances of this nature have arisen, and some dealers have not been able to overcome the temptation to cast a reflection upon their competitors. And while this was going on these very competitors had other equally important items of stock which the gossiping store had not. In the long run remarks to customers regarding other people's lack of stock strike home very severely when the customer realizes the general condition in the business at present, which most customers do.

There is not too much of the golden rule in business, but it is doubtful if a better rule can be devised for the guidance of any radio dealer who intends to go into the business to stay.